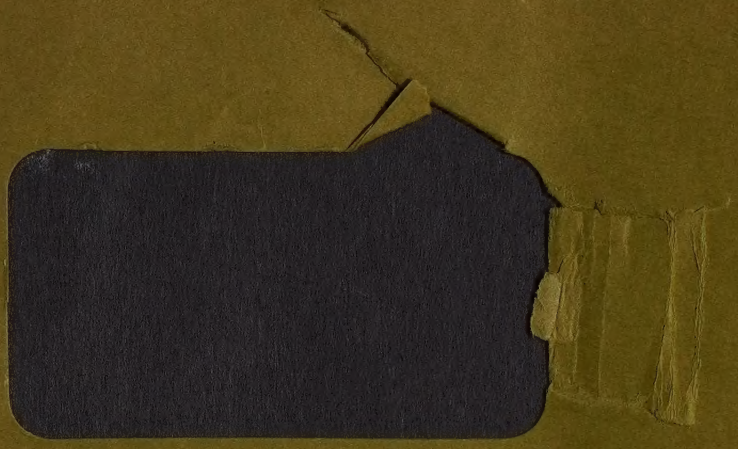

Beckman

Operating and Servicing Manual

Electronic Instruments Division

MODELS
6003A, 6004A, 6005A
ACCUMULATORS

(PREFIX 500)

SERIAL NO._____

Beckman® INSTRUMENTS, INC.
ELECTRONIC INSTRUMENTS DIVISION
3900 RIVER ROAD

April 1967

38835 10 72

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BECKMAN INSTRUMENTS

6003A -14

CLOCK

SPECIFICATIONS

1. Instrument accumulates to 9 hours, 59 minutes, 59.9 seconds at a .1 second rate then recycles.

2. The .1 second clock pulses are derived from a 100kHz crystal oscillator.

3. Decimal point and colons are provided in the display.

4. No set provision is provided.

5. Reset is by front panel pushbutton.

6. BCD code and update inhibit are provided on a rear panel connector.

DATE RELEASED ____ SPECIAL PRODUCTS JOB NO. ____ QTY ____

RELEASED BY ____

BILL OF MATERIALS

DATE NEEDED ____

DELIVER TO ____ MODEL 6003A DJ DM-14 DATE STOCK ISSUED ____

INV	CLASS	PART No	NON DIV STK	ITEM DESCRIPTION	TYPICAL MANUFACTURER & No	ALL DETAIL NO'S INVOLVED	UNIT TOTAL	QUAN FROM STOCK	SHORT
62	887	426251		Timing Control Bd.			1		
62	887	426107		Bi Qui Small			4		
62	887	427200		Bi Qui Fwd-Latch			6		
62	887	431244		100KHZ Osc Bd.			1		
20A	881	401955		100 KHZ Crystal			1		
20	680	824115		Connector, 15 Pin, Dual			8		
20	680	823481		Connector, 15 Pin, Single			3		
20	672	814649		Connector 50 pin			1		
20	670	854373		Connector BNC			1		
20	716	827410		Switch, DPDT, Slide			1		
20	633	836864		Capacitor .01			1		
20	637	819448		Capacitor 100pf			2		
20	633	812052		Capacitor 56pf NPO			1		
20	655	824658		Capacitor .6-14 pf			1		
20	601	822371		Resistor, 390 Ω, 1/4W, 5%			1		
20	601	823904		Resistor 100K, 1/4W, 5%			5		
20	860	841614		Socket, Glow Tube			1		
20	885	431044		Resistor Module			1		

Beckman® INSTRUMENTS INC. BERKELEY DIVISION RICHMOND CALIFORNIA

DATE 2-1-68 COMPILED BY Paul Thomas SHEET 1 OF 2

Form No. 62-23.06

RELEASED BY _____ SPECIAL PRODUCTS No _____ QTY _____

BILL OF MATERIALS

DELIVER TO _____ MODEL 6003A DJ DM-14 DATE NEEDED _____ DATE STOCK ISSUED _____

INV	CLASS	PART No	NON DIV STK	ITEM DESCRIPTION	TYPICAL MANUFACTURER & No	ALL DETAIL NO'S INVOLVED	UNIT TOTAL	QUAN FROM STOCK	SHORT
20	823	844443		Glow Tube W/D.P.			1		
40	327	419568		Bd. Support			2		
40	327	423273		Capacitor Mtg. Bracket			1		
20	691	836659		Terminal Block 2pt			1		
20	601	822326		Resistor, 1.2k, 1/4W, 5%			1		
40B	327	429437		Glow Tube Bracket	From 3761A end Cut Off		2		
40A	693	429444		Lamp Bd Asy	From 3761A		2		
20	825	811836		Neon NE-2L			4		
40A	510	429442		Colon Legend	From 3761A		2		
40B	299	427823		Legend Block	From 3761A		2		
40A	327	428425		Legend Mt. Bk. 1 Digit			2		

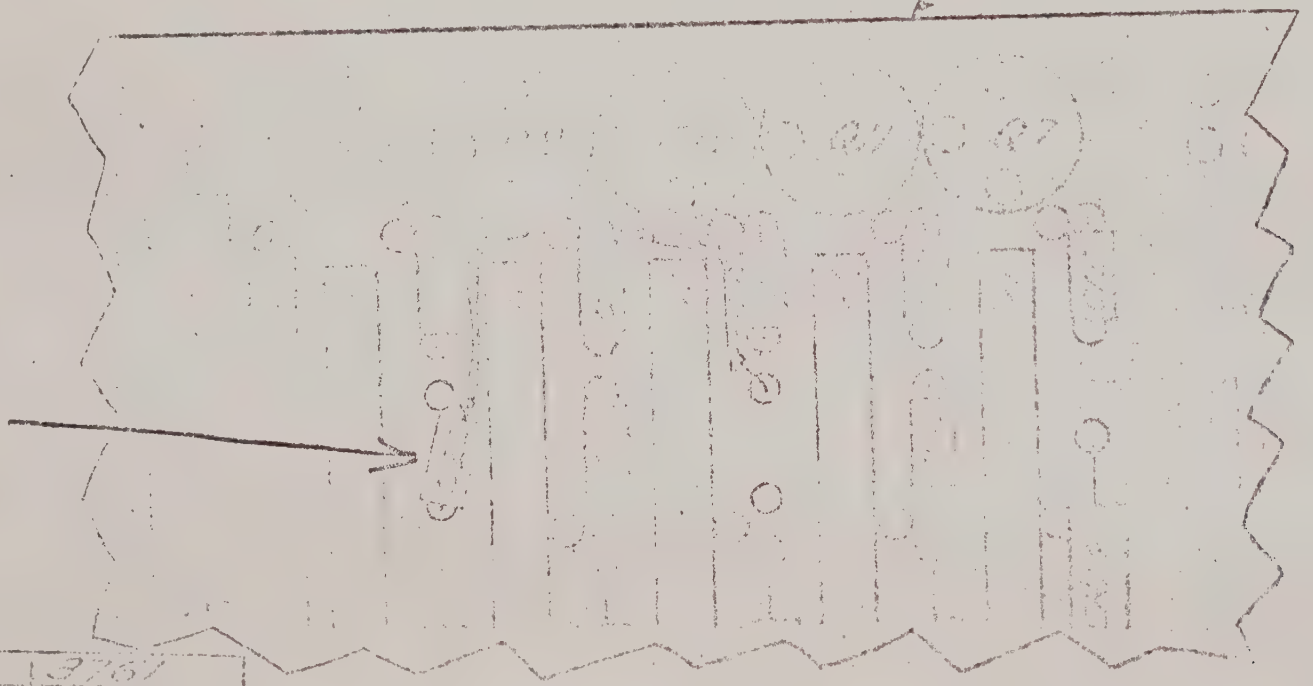
Beckman® INSTRUMENTS INC. BERKELEY DIVISION RICHMOND CALIFORNIA

DATE 2-1-68 COMPILED BY Paul Thomas SHEET 2 OF 2

Form No. 62-23.06

INSTRUCTIONS:
- DELETE C16 AND C20.
- ADD C22 (WIRE SHOWN USING SPAGHETTI ON ONE LEAD AS NEEDED.
- HAND STAMP "÷6" ON TOP FRONT EDGE.

BI-QUI-DCU WITH P/O A105-205 & A107-207



TO P4

ITEM	PART NO.	DESCRIPTION	Q
		DIVIDE BY SIX (÷6) MOD. TO BI-QUI-DCU	

010-429510 A

ADDENDUM A

MODELS 6003A, 6004A, 6005A

For all Input Amplifier boards stamped with revision letter "E".

1) To take the schematic diagram (dwg. no. D425640-Rev. F) to revision level E, reverse the polarity of pins N and R. Change the revision letter to "E".

2) Change the component layout (dwg. no. C425611-Rev. F) revision letter from F to E to agree with the actual board revision letter.

MODELS 6003A, 6005A, 6005A

For all Fwd. DCU w/Glo-Tube Readout boards stamped with revision letter "D":

1) To bring the schematic diagram (dwg. no. D427791-Rev. C) to revision level "D", change all diodes with part no. 755-815561 (1N3064) to part no. 755-431324. Change the schematic revision letter to "Rev. D".

2) Change the component layout (dwg. no. D427792-Rev. C) to "Rev. D" to agree with the actual board revision letter.

3) Change the parts list to agree with the above.

MODELS 6003A, 6004A, 6005A

For all Fwd. DCU w/Glo-Tube Readout Boards stamped with revision letter "B":

There is no difference between schematic diagrams or component layout drawings labelled "B" and "C". If the board is stamped with "Rev. B", simply change the revision letters of your drawings to "B", so the drawing and board will be in agreement.

ADDENDUM C

MODELS 6003A, 6004A, 6005A

Please note the following errors in your manual:

1) "DESCRIPTION - Models 6003A, 6004A, 6005A", Page 3, Table 2:

   The last entry in column labelled "Glow-Tube Socket Pin Number" should be 3 instead of 12.

2) The revision letter for the Preset Board Component Layout, Page 5-5, (dwg. no. C426025) and Preset Schematic Diagram, Page 5-5a, (dwg. no. D425936) should be "D" instead of "E".

3) PLEASE NOTE: Page A3-6 has been inadvertently printed on the back of Page B3-5.

ADDENDUM D

MODELS 6003A, 6004A, 6005A

For all Accumulator Control assemblies stamped with revision letter "G-1":

1) To bring the schematic diagram (dwg. no. D425094-Rev. G) up to revision level "G-1", add resistor R59, 3.3K, 1/4W, 5%, (part no. 601-822296) between the collector of Q3 and ground. Change transistor Q7 (2N1420) to part no. 755-419596.

   Change the schematic revision letter to "Rev. G-1".

2) To bring the component layout drawing (dwg. no. D425470-Rev. G) up to revision level "G-1", add resistor R59 between collector of Q3 and ground. Change the revision letter to "Rev. G-1".

3) Change the parts list, on the back of Page 5-3, to agree with the above.

MODELS 6003A, 6004A, 6005A

For all Preset boards stamped with revision letter "F":

To bring the component layout drawing (no. C426025-Rev. E) on Page 5-5 up to revision level "F", add Capacitor C10 and Resistor R39, as shown in Figure 1.

To bring the schematic diagram on Page 5-5a (dwg. no. D425936-Rev. E) up to revision level "F", change Resistor R21 to 2.2K, 1/4W, 5%, part no. 601-822297; add Resistor R39 (same value as R21); and add Capacitor C10, 47pf, 500V, 10%, part no. 633-839568, as shown in Figure 2.

Change the parts list on the back of Page 5-5 to agree with the above.

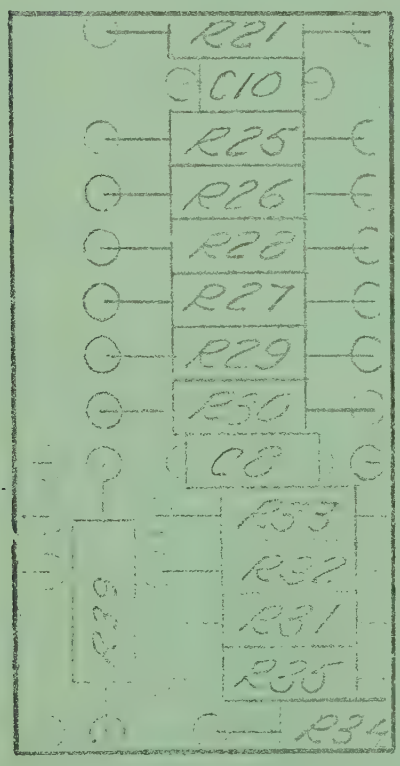


Figure 1

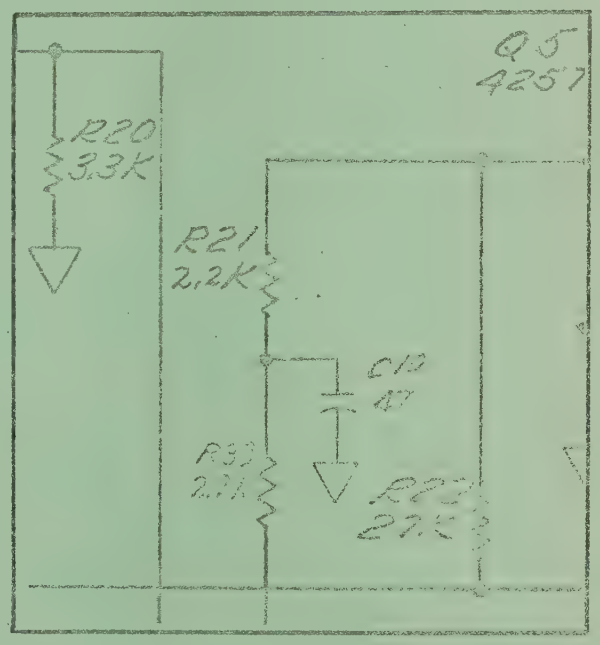


Figure 2

MODELS 6003A, 6004A, 6005A

For all Accumulator Control assemblies stamped with revision letter "H":

There are no differences between the "Rev. G-1" and "Rev. H" schematic diagrams and component layout drawings.

MODELS 6003A, 6004A, 6005A

PLEASE NOTE

"Page A3-6" has been inadvertently printed on the back of "Page B3-5".

ADDENDUM F

MODELS 6003A, 6004A, 6005A

For all Fwd. DCU w/Glo-Tube Readout boards stamped with revision letter "E";

1) To bring the schematic diagram (dwg. no. D427791-Rev. D) to revision level "E", change R5 from 2.7k to 2.2k (p/n 601- 822328: 1/4w, 5%) and add CR43 between gnd and emitter of Q25.

2) Change the parts list and component layout (dwg. no. D427792-Rev. D) to "Rev. E" to agree with the above changes.

CONTENTS

Page

DESCRIPTION - Models 6003A, 6004A, 6005A
(Pages 1 through 4)

MODELS 6003, 6004, 6005 INSTRUCTION MANUAL
(Sections 1 through 4, Parts A and B)

SECTION 5 PARTS LIST and DRAWINGS

NOTE

The Parts List for each board is shown with its respective component layout drawing and schematic diagram. Miscellaneous components are shown on the Outline Drawing.

Outline Drawing (dwg. no. 65-C-6000-001) 5-1

Board Location Diagram (dwg. no. R427291) 5-2

Accumulator Control Component Layout (dwg. no. D425470) 5-3
Accumulator Control Schematic Diagram (dwg. no. D425094) 5-3a

Input Amplifier Component Layout (dwg. no. C425611) 5-4
Input Amplifier Schematic Diagram (dwg. no. D425640) 5-4a

Preset Board Component Layout (dwg. no. C426025) 5-5
Preset Schematic Diagram (dwg. no. D425936) 5-5a

Forward DCU w/Glo-Tube Readout Component Layout (dwg. no. D427792) 5-6
Forward DCU w/Glo-Tube Readout Schematic Diagram (dwg. no. D427791) 5-6a

Regulator Board Component Layout (dwg. no. C426753) 5-7
Power Supply Schematic Diagram (dwg. no. C426752) 5-7a

SECTION 6 APPENDICES

Logic Symbols and Typical Circuits

Options

DESCRIPTION

GENERAL

Except as noted in the following paragraphs, all information in the Models 6003, 6004, and 6005 instruction manual applies to the Models 6003A, 6004A, and 6005A instruction manual.

INTRODUCTION

The five-digit front panel edge-lit display has been replaced by a group of five numerical glow-tube indicators (see figure 1). Table 1 gives the specifications of these glow-tubes.

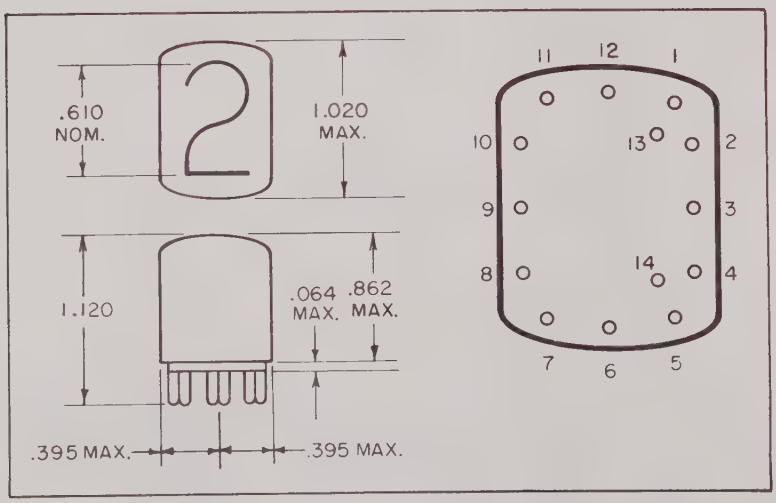


Fig. 1. Glow-Tube Specifications

Table 1. Glow-Tube Specifications

Type	B5991 Ultra Long Life Rectangular
Absolute Ratings	
Ionization Voltage (Max)	170Vdc
Supply Voltage (Min)	170Vdc
Cathode Current (Peak)	3.5 ma
Test Conditions	
Supply Voltage	180Vdc
Series Resistor	8.2 K
Cathode Current (Min)	1.5 ma
(Max)	3.0 ma

PIN CONNECTIONS	
Pin No.	Characters
1	Anode
2	Numeral 0
3	Numeral 9
4	Numeral 8
5	Numeral 7
6	Numeral 6
7	Numeral 5
8	Numeral 4
9	Numeral 3
10	Numeral 2
11	Numeral 1
12	Internal Connection
13	Internal Connection
14	Internal Connection

OPERATION

Figure 2-1 in the appended instruction manual is no longer applicable.

THEORY OF OPERATION

The five count-chain DCU's (decimal counting units) described in paragraph 3.6 of the appended instruction manual, have been replaced by five DCU's which are designed to drive glow-tube indicators. Refer to the Biquinary DCU (Forward Only, With Readout) Schematic Diagram, (drawing no. D427791).

The basic counting circuitry in these DCU's is the same as that used in the previous DCU's. However, the output from this DCU consists of ten lines in decimal code; each line drives a single cathode in the glow-tube indicator associated with the DCU. These ten lines are derived from the basic counting circuitry via ten buffer amplifiers. Table 2 shows the interconnections between the DCU and the glow-tube indicator. This table replaces figure 3-9 in this instruction manual.

Table 2. DCU to Glow-Tube Interconnections

Glow-Tube Numeral	DCU Pin Number	Glow-Tube Socket Pin Number
0	3_R	2
1	4_R	11
2	5_R	10
3	6_R	9
4	7_R	8
5	8_R	7
6	9_R	6
7	10_R	5
8	11_R	4
9	12_R	12

SERVICING

A change has been made in the power supply: the -32 volt dc supply has been replaced by a +175 volt dc supply, which is used to energize the anodes of the glow-tube indicators.

Figure 2 replaces figure 4-1 in the appended instruction manual; figure 3 replaces figure 4-2 in the appended instruction manual.

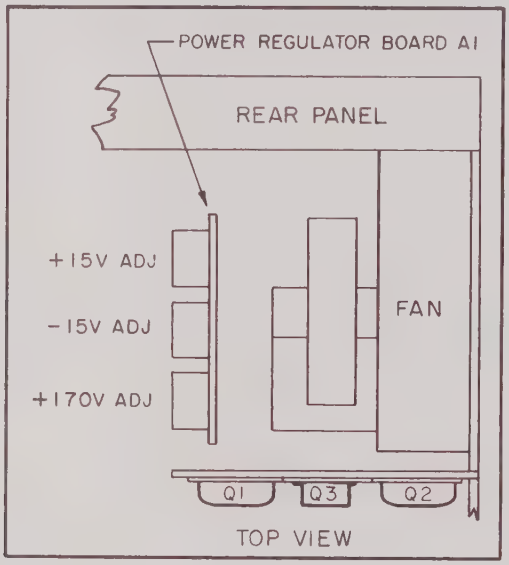


Fig. 2. Location of Power Supply Adjustments

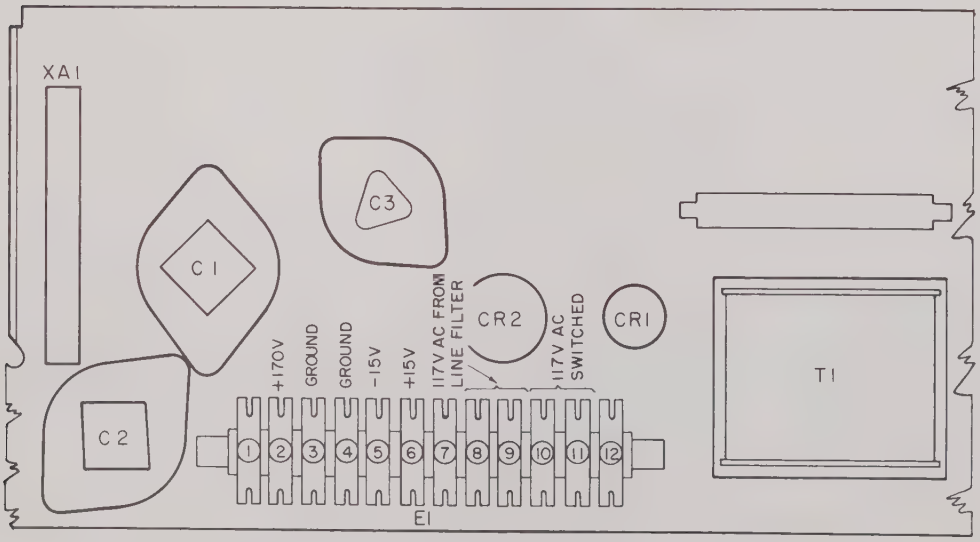
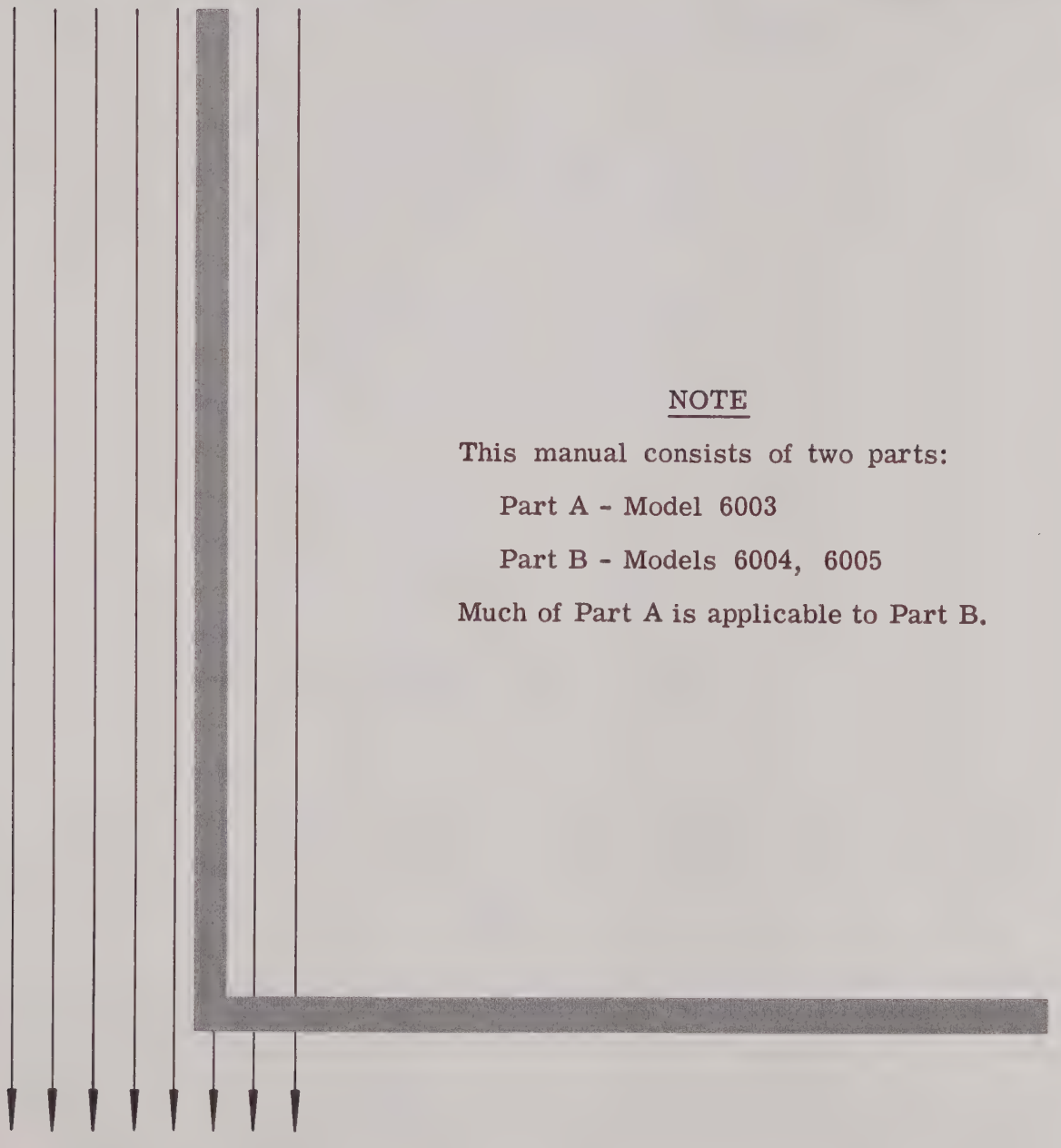


Fig. 3. Power Supply Test Points

INSTRUCTION MANUAL

MODELS 6003, 6004, 6005, ACCUMULATORS



NOTE

This manual consists of two parts:

Part A - Model 6003

Part B - Models 6004, 6005

Much of Part A is applicable to Part B.

Beckman® INSTRUMENTS, INC.
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September 1965

INTERNATIONAL SUBSIDIARIES: Geneva; Munich; Glenrothes, Scotland; Tokyo; Paris; Capetown; London; Mexico City.

PRINTED IN U.S.A.

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Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

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PART B: (Models 6004, 6005)

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continued. . .

PART B - continued:

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SEC. 5 PARTS LIST

APPENDIX

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Input Amplifier P.C. Board	C425611
Regulator P.C. Board	C423795
Preset P.C. Board	C426025
Bi-Quinary DCU (Forward Only) with Readout	C426101

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Input Amplifier Schematic	D425640
Preset Schematic	D425936
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Bi-Quinary DCU with Readout, Forward Only, Schematic	D426095
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PART A

SECTION 1
INTRODUCTION

1.1 GENERAL

The Models 6003, 6004 and 6005 Accumulators are high speed, solid-state accumulators. Each is basically a five-digit, in-line readout instrument with a maximum counting rate of 2 mc and an absolute storage capacity of 99,999.

The Model 6003 performs as a basic accumulator. It is able to accept a single line of input data and add this to the prior accumulated sum. The new sum is algebraically displayed on a five-digit, in-line, edge-lit readout display.

Input connectors and minor controls are located on the rear of the instrument or are internal adjustments.

1.2 SPECIFICATIONS

Specifications for the Model 6003 are listed in Table 1-1.

Table 1-1. Specifications

Function	Adds counts to accumulated sum.
Counting Rate	Counts sine wave input dc to 2 mc. Counts random input pulses as closely spaced as 0.5 μs.
Input Signal Characteristics	
Sensitivity	1 V rms.
Overload	300 V rms.
Impedance	200 K ohms.
Shunt	40 pf.
Coupling	DC.
Dynamic Range	1 - 100 V rms.
Pulse Width	250 Nanoseconds minimum.

continued . . .

Table 1-1. Specifications - continued

Gate Control	GATE ON: Count gate is open. GATE OFF/REMOTE: Gate control is on remote connector. Count gate can be controlled open (pin 33 grounded) or closed (pin 33 open circuit).
Display Data Word	5 Digits, 00000 to 99999 in-line edge-lit readout. Display is continually updated during counting.
GATE OPEN Indicator	Indicates condition of count gate (open or closed).
Trigger Adjustment	±10 V internal adjustment.
Environmental Specs. Temperature Humidity Altitude	 Operating: 0°C to 55°C. Storage: -18°C to 75°C. Operating: 85% RH; 40°C, 24 hrs. Operating: 10,000 ft. maximum. Storage: 50,000 ft. maximum.
Power Requirements	115 V ac; 50-60 cycles, 51 watts.
Dimensions	3-1/2" x 19" x 17" HWD
Weight	26 Lbs.

1.3 OPTIONS

Table 1-2 lists the options available with the Model 6003.

Table 1-2. Options with Models 6003, 6004, 6005

Option	Description
DE	Relay rack slides.
DH	230 V ac line voltage. Power transformer wired for 230 volts ±10%, 50 to 50 cycles.
DJ	Binary coded decimal output. Five digits of 4-line (1-2-4-8) BCD output at rear panel 50-pin connector, Amphenol type 57-40500. Includes: Logic Level + sign 1 - sign 0 overflow 1 no overflow 0 Note: "1" = 0.8 V, 5 ma "0" = 10 V, 0.2 ma
DM	Addition of 6th digit and OVERFLOW to display available at rear-panel connector.
DO	Model 6004 only: Addition of relay output at preset coincidence. Model 6005 only: Addition of relay output at each preset coincidence.
DQ	Tilt-foot handles to replace rack-handle adaptors.

PART A

SECTION 2

OPERATION

2.1 GENERAL

Figure 2-1 shows the Model 6003 front panel. The Model 6003 can accept a single line of input data having a maximum frequency of 2 mc. This input is algebraically added to the total already present in the accumulator. With the gate in either the ON or REMOTE position, the accumulator can continually count, store and display the sum until new data is applied at the input. With the gate in OFF/REMOTE, the data is stored and displayed indefinitely.

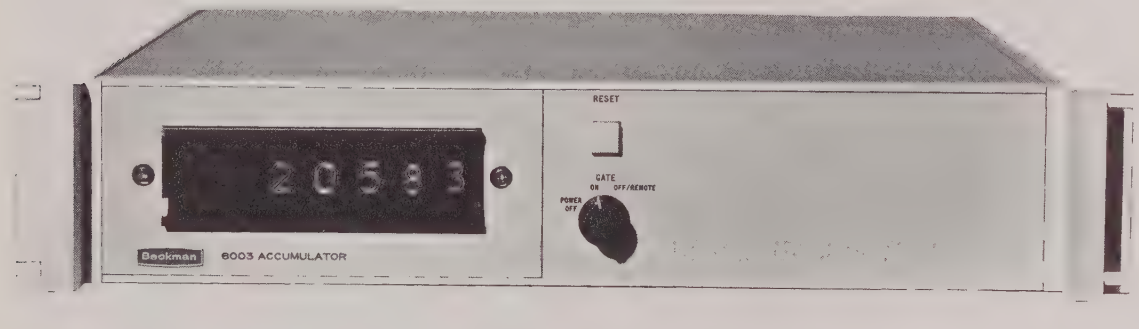


Fig. 2-1. Model 6003 Front Panel

2.2 APPLYING POWER

The instrument is ready to use as it arrives from the factory. To energize the instrument, plug the power cord into a 117v ac, 50 to 60 cycle source. Turn the GATE switch to ON or OFF/REMOTE, thus energizing all circuits in the instrument.

2.3 EXTERNAL CONTROLS AND CONNECTORS

Most operating controls are located on the front panel as shown in Figure 2-1. Input connector, remote connector and space for optional BCD data output connector are located on the rear panel. See Figure 2-2.

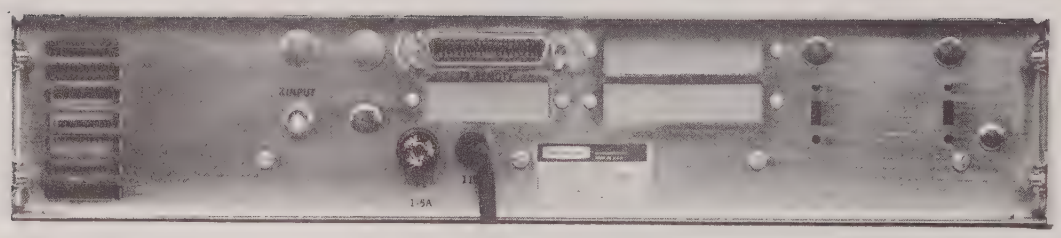


Fig. 2-2. Models 6003, 6004, 6005 Rear Panel

Table 2-1 explains each control on the front panel. Table 2-2 explains the function of each rear panel connector.

Table 2-1. Front Panel Controls (Model 6003)

GATE Switch	In ON or OFF/REMOTE, all circuits in the instrument are energized. ON: Count gate is open and the instrument accumulates data appearing at X INPUT. OFF/REMOTE: Gate control is transferred to the remote connector. With Pin 33 grounded, count gate is open. With Pin 33 open circuit, count gate is closed. With the GATE switch in OFF/REMOTE, Pin 32 on the remote connector is at ground.
RESET	At any instant of time, the accumulator can be reset to zero by pressing the RESET button.

Table 2-2. Rear Panel Connectors

X INPUT Connector, J1 (Type BNC)	X input data is applied at this connector.
REMOTE Connector, J2 (36-Pin Amphenol 57-40360)	Provides remote selection of slope, remote gate control, and remote reset. (Refer to Table 2-3.)

2.3.1 REMOTE Connector (J2)

A 36-pin connector, J2, permits remote gating, slope selection, and reset. In all cases, desired gating, slope selection, and reset requires only a contact closure to ground of the proper pins(s). Table 2-3 shows pin numbering on the remote connector.

Table 2-3. Model 6003 Remote Connector Pin Numbers

Pin Number	Function	Pin Number	Function
1	X Slope Select	19	*
2	Ground	20	*
3	*	21	*
4	*	22	*
5	*	23	*
6	*	24	*
7	*	25	*
8	*	26	*
9	*	27	*
10	*	28	*
11	*	29	*
12	*	30	*
13	*	31	*
14	*	32	Ground when GATE is OFF/REMOTE
15	*	33	Gate ON
16	*	34	*
17	*	35	Ground
18	*	36	Remote Reset

*Not used in standard Model 6003.

2.4 INTERNAL CONTROLS

2.4.1 Triggering Level Adjustment

The triggering level adjustment and test points are located on the amplifier boards and are accessible from the top of the instrument. There are two test points marked on the board: LEVEL and TEST. Voltage appearing at the LEVEL terminal is the actual triggering level, i.e., value which the input voltage must exceed in order to trigger the input circuit. Voltage appearing at TEST is the actual output from the amplifier.

The adjustment procedure is as follows:

1) Connect a voltmeter of at least 1% accuracy to the LEVEL test point and an oscilloscope to the TEST output.

2) Connect a signal generator to the amplifier input and set the rms voltage to the desired level using a 100 kc signal.

3) Using the potentiometer mounted on the amplifier board, adjust the discriminator for maximum sensitivity. This is indicated by the appearance of an output pulse train with approximately a 50% duty cycle.

4) Continue triggering level adjustment until the output pulse triggers at the desired instant of time. This is done by shifting the occurrence time of the output leading edge.

5) The actual triggering level (plus hysteresis) is indicated by the dc voltmeter. A reading of about 0 volts indicates maximum sensitivity.

2.4.2 Slope Selection

The Slope control is a contact closure to ground on pin 1 of the remote connector. It determines which slope (positive or negative) of the input signal will trigger an output pulse. Figure 3-3 in Section 3 shows the voltage discriminator output with a sine wave input and the effect of + and - slope selection.

Select the desired slope as follows:

1) For positive (+) slope triggering, pin 1 on the remote connector (J2) must be an open circuit.

2) For negative (-) slope triggering, the same pin must be grounded.

SECTION 3

THEORY OF OPERATION

3.1 INTRODUCTION

This section describes the basic operating theory of the Model 6003. Information in this section is primarily from a functional approach and minimizes any detailed description of circuit operation.

Logic symbols are defined in the Appendix and are listed along with typical circuits.

3.2 GENERAL OPERATION

The functional boards in the Model 6003 are shown in Figure 3-1, a foldout drawing appearing at the end of Section 3, Part B. Information from the data source to accessory recorders and readout display is transmitted through the instrument according to the following sequence.

1) Data is applied at the input to the X amplifier. The amplifier generates a positive true output which is triggered by the positive or negative slope of the applied signal. Output pulse duration is determined by the time the applied signal exceeds the discriminator level. The output is applied to the forward line of the accumulator control board.

2) The accumulator control board provides the necessary gating action in the instrument. A signal on the forward input line is either transmitted to the decimal counters or terminated in the control board, depending on the state of the count gate (open or closed). The reset generator is also on the accumulator control board.

3) The decimal counting units (DCU's) perform the basic addition operations and store the accumulated sum. A signal on the forward input line increases the absolute value of the accumulated sum.

   The DCU's provide outputs to decimal indicator lamps in the display.

3.3 INPUT AMPLIFIER

The input amplifier consists of a discriminator amplifier input circuit followed by slope selection logic.

The discriminator circuit is a differential amplifier using regenerative positive feedback. The use of such feedback and dc switching levels insures the fast switching time which is essential in high frequency applications.

The slope selection logic permits triggering on either the positive or negative slopes of the input signal. An input to the discriminator circuit generates a 1.4 volt p-p positive true signal to the slope selection circuit and appears at the amplifier output as a positive true pulse (-7 volts to ground). If a positive slope is selected, the output is triggered by the leading edge of the discriminator output, whereas if a negative slope is selected, the output is triggered by the trailing edge. Figure 3-2 shows the slope selection logic. Figure 3-3 shows the result of amplifier discrimination and slope selection.

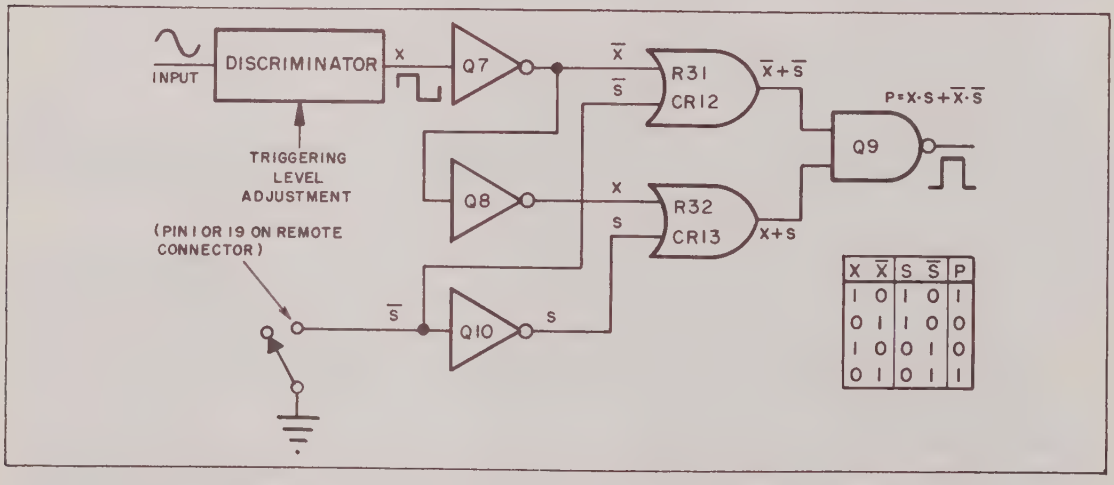


Fig. 3-2. Slope Selection Logic Diagram

3.4 ACCUMULATOR CONTROL BOARD

3.4.1 General

A logic diagram for the accumulator control board is shown in Figure 3-4. The board contains two circuits: a reset generator circuit and a count gate circuit.

3.4.2 Reset Generator

Reset is a contact closure to ground which triggers a 400 nanosecond positive-true pulse to all DCU's. It also triggers a 400 nanosecond

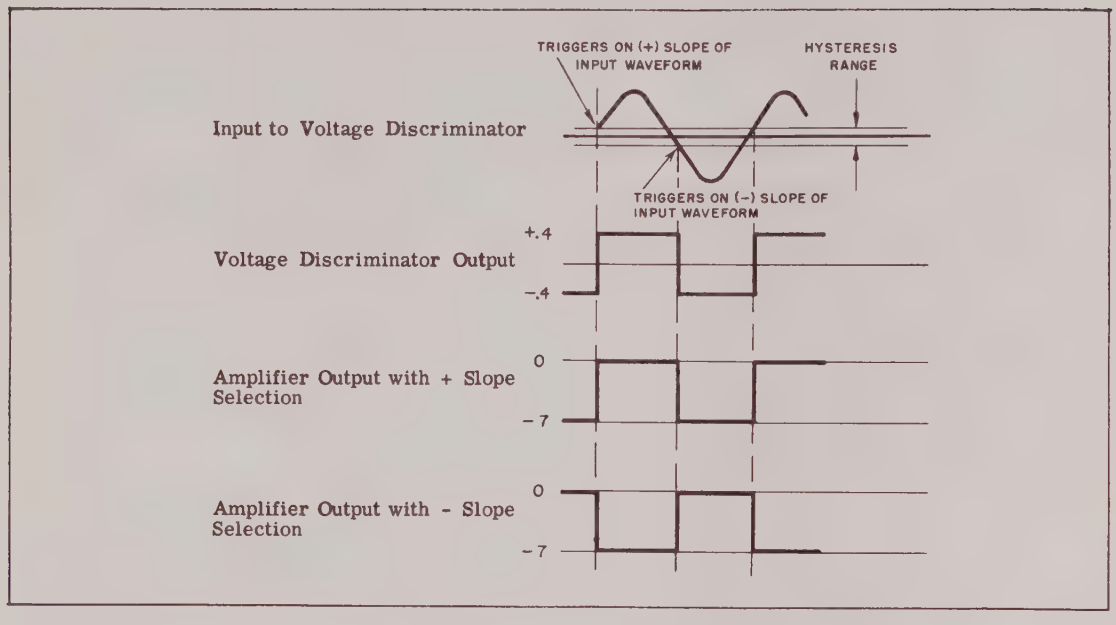


Fig. 3-3. Amplifier Input and Output Signals

negative-true reset pulse to all flip-flops. The reset pulse for the DCU's appears at the emitter of Q7 (Pin R_F), while the reset pulse for the flip-flops appears at the emitter of Q5 (Pin N_F).

3.4.3 Count Gate

The front-panel GATE switch in the ON position grounds Pin E_F (logic "1") and causes the AND gate to the forward single-shot to open (the reverse single-shot is not used in the Models 6003, 6004, 6005). A forward pulse from the input amplifier then is able to activate an output single-shot, producing a positive true (-12 volts to ground), 200 nanosecond pulse to the decimal counting units. The forward count appears at the collector of Q14 (Pin R_R).

3.5 DECIMAL COUNTING UNITS (DCU's)

The basic counting circuits in the instrument consist of a chain of five decimal counting units connected in tandem. Each DCU provides outputs to the display, and can provide BCD outputs to external recorders (option). (In the Models 6004 and 6005 Preset Accumulators, each DCU also provides a signal to the preset switches indicating preset coincidence.)

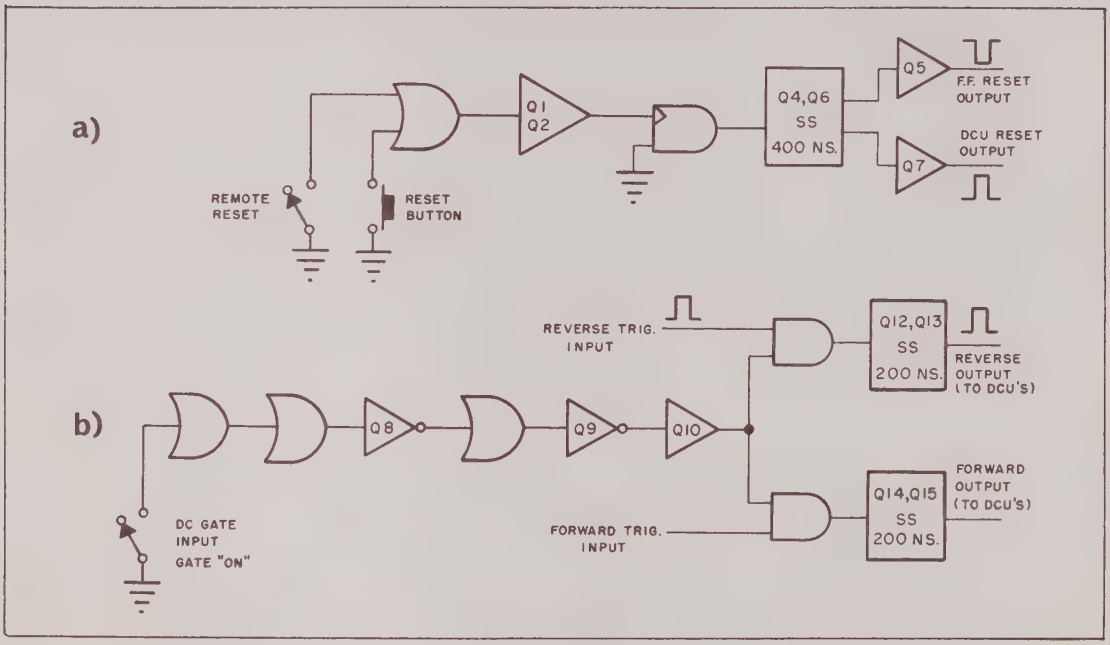


Fig. 3-4. Accumulator Control Board Logic Diagram
a) Reset Generator Logic. b) Count Gate Logic

Since each DCU generates one output pulse for every ten input pulses, the bank of five DCU's performs as a decimal counter with an absolute capacity of 99,999.

The DCU's used in the Models 6003, 6004, and 6005 are "forward only" counting units, that is, a single input pulse to the DCU always results in an increase in decimal absolute value of one.

3.5.1 DCU Technical Characteristics

Table 3-1 lists the technical characteristics of the DCU.

Table 3-1. DCU Technical Characteristics

Input Requirements	Positive true pulse or voltage step, 5-7 volts p-p; less than 6 nanosecond rise time; pulse duration at least 150 nanoseconds; a low impedance source (180 ohms or less at 0 volt input).
Counting Rate	0-2 Mc in forward direction, requires at least 0.5 μs between successive input pulses.
Output	Binary coded decimal outputs (OPTION). Available outputs to preset switches (Models 6004, 6005, only).

3.5.2 DCU Operation

The "forward only" DCU divides by 10 in two steps: division by two then division by five. This type of division requires a binary stage followed by a quinary stage. Therefore, the actual "count" is represented by the states of seven transistors. The bi-quinary decimal code is shown in Table 3-2. The logic voltage levels have been reversed in the bi-quinary as noted in the Table. A "forward only" DCU logic diagram is shown in Figure 3-5.

The binary section alternates between 0 and 1, and changes the state of the quinary once with the acceptance of every two incoming counts. The quinary provides an output to the next DCU in the chain, and returns to its original state after every five counts are received from the binary.

The binary changes state when a Fwd count is received, whereas the quinary changes states progressively in the "forward" direction.

Progressive change in the forward direction occurs when there is an increase in magnitude from an odd number to an even number.

This is reflected in the circuitry when a higher order transistor turns OFF. For example, assume the DCU displays a decimal "3". Then all quinary transistors would be ON except for Q8. Progressing forward to decimal "4" requires all quinary transistors to be ON except for the next higher order transistor, Q9. For a progressive change in the forward direction to occur, the circuit requires that Q2 is OFF and that a count is received. If only the latter occurs and Q2 is ON, the quinary does not change.

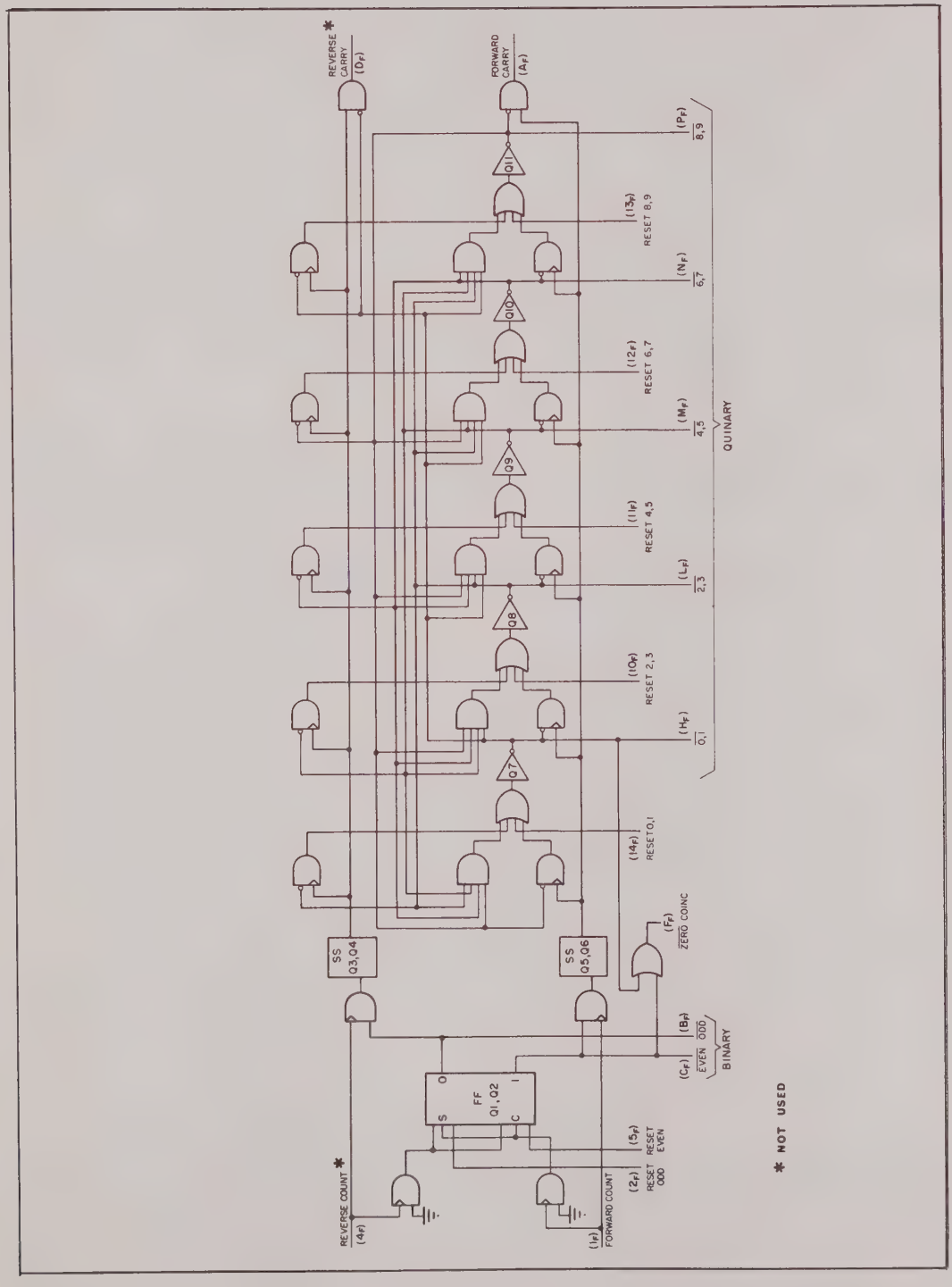


Fig. 3-5. Decimal Counting Unit Logic Diagram

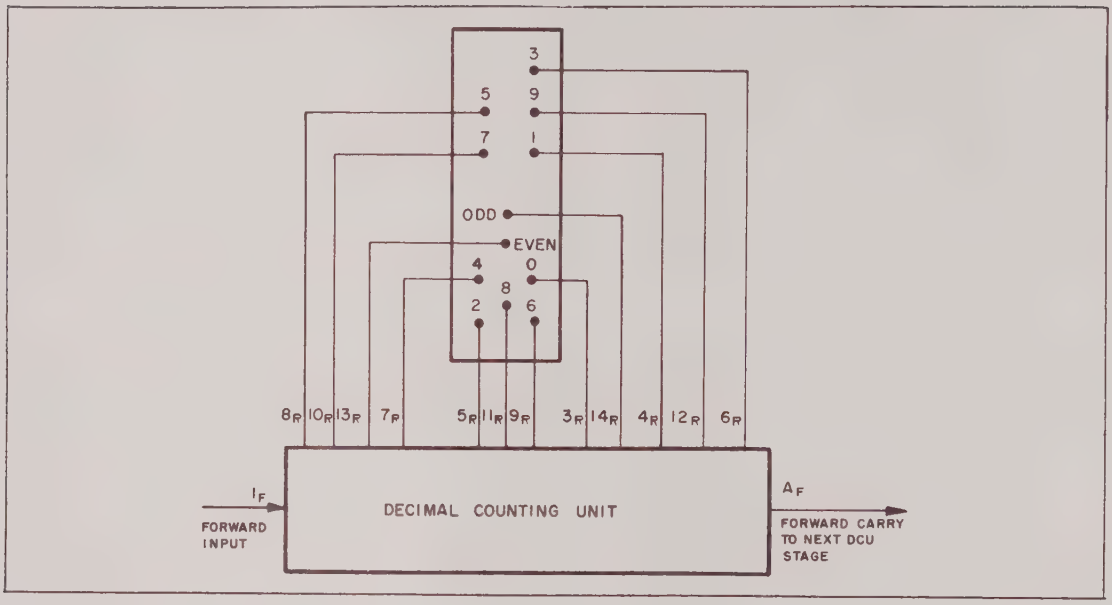


Fig. 3-6. Lamp Block - DCU Interconnection

PART A

SECTION 4

SERVICING

4.1 GENERAL

This section provides adjustment procedures and troubleshooting information for the 6000 Series Accumulators.

4.1.1 Required Test Equipment

Table 4-1 lists the test instruments required for servicing the accumulator.

Table 4-1. Recommended Test Equipment

Instrument	Specifications
Oscilloscope	50 mc bandwidth, 3.5 nanosecond rise-time.
Signal Generator	1 cps to 100 kc, 1 volt rms output.
Signal Generator	100 kc to 2 mc, 1 volt rms output.
Volt-Ohmmeter	100,000 ohms/v dc.
Auto Transformer	0 - 130 volts ac, 60 cps.

4.1.2 Printed Circuit Board Identification

Table 4-2 lists the printed circuit boards used in the 6000 Series Accumulators.

Table 4-2. Printed Circuit Boards Used in 6000 Series Accumulators

P.C. Board Detail No.	Description	Model					
		6003	6004	6005	6013	6014	6015
A2	10^4 FWD/REV DCU	x	x	x	x	x	x
A3	10^3 FWD/REV DCU	x	x	x	x	x	x
A4	10^2 FWD/REV DCU	x	x	x	x	x	x
A5	10^1 FWD/REV DCU	x	x	x	x	x	x
A6	10^0 FWD/REV DCU	x	x	x	x	x	x
A7	Accum. Control	x	x	x	x	x	x
A8	X Amplifier	x	x	x	x	x	x
A9	Preset N_1		x	x		x	x
A10	Preset N_2			x			x
A11	Y Amplifier				x	x	x
A12	FWD/REV Logic				x	x	x

4.1.3 Component Location

Use the drawing on the inside top cover of the instrument to locate assemblies and components which are mounted on the main chassis. Components on printed circuit boards may be located using the layout drawings furnished in the manual.

4.1.4 Extension Boards

Two extension boards are supplied with the instrument to provide easy access to components and test points on printed circuit boards during operation.

4.2 ADJUSTMENTS

4.2.1 Power Supply Adjustments

The regulated power supply adjustments are located on Regulator Board A1 (Figure 4-1).

Power supply test points are located on the bottom of the chassis along a horizontal terminal strip (Figure 4-2). Wires from the three terminals are color coded as follows: RED +15V, GREEN -15V, YELLOW -32V.

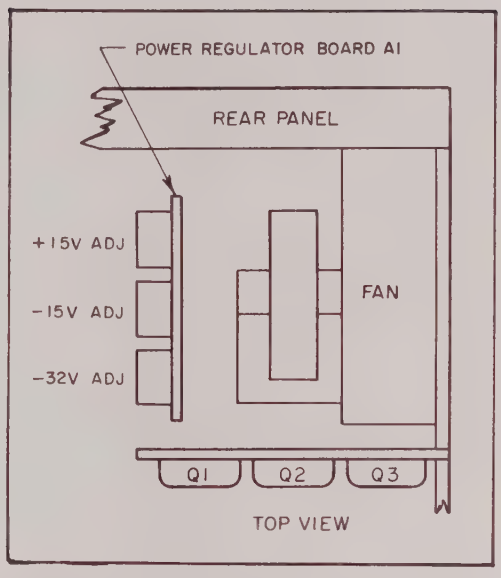


Fig. 4-1. Location of Power Supply Adjustment

4.2.1.1 Adjustment Procedure

CAUTION

Do not remove the Regulator Board (A1) from its receptacle without first unplugging the AC line cord from its power source.

1) Use a voltmeter of at least 1% accuracy. Voltage measurements are referenced to chassis ground.

2) Use Figure 4-2 to locate power supply test points.

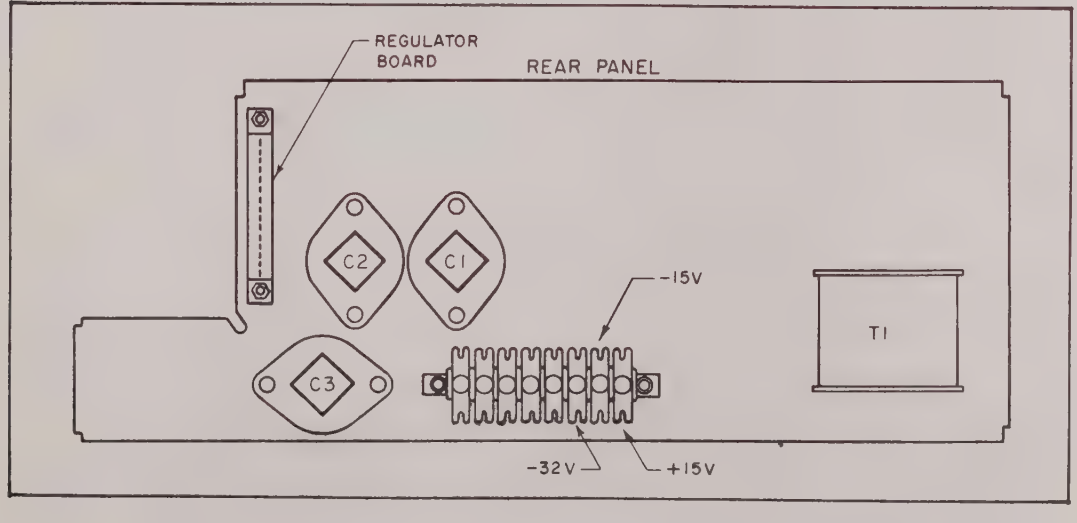


Fig. 4-2. Location of Power Supply Test Points

3) Adjust +15 V ADJ to +15 volts, ±0.2 volt.

4) Adjust -15 V ADJ to -15 volts, ±0.2 volt.

5) Adjust -32 V ADJ to approximately -29.5 volts.

4.2.2 Triggering Level Adjustment

The trigger level adjustment and test points are on the amplifier boards and are accessible from the top of the instrument. There are two test points marked on the board: LEVEL and TEST. Voltage appearing at the LEVEL terminal is the actual triggering level, or value which the input voltage must exceed in order to trigger the input circuit. Voltage appearing at TEST is the actual output from the amplifier. Maximum sensitivity occurs when the level is near zero volts.

4.2.2.1 Adjustment Procedure

1) Connect voltmeter of at least 1% accuracy to LEVEL and OSCILLOSCOPE to TEST.

2) Connect signal generator to amplifier input. Using a 100 kc signal, set the rms voltage to the desired level.

3) Using the potentiometer mounted on the amplifier board, adjust the discriminator for desired sensitivity. Maximum sensitivity is indicated by the appearance of an output pulse train with approximately 50% duty cycle.

4) Actual triggering level (plus hysteresis) is indicated by the dc voltmeter; a reading of approximately 0 volts indicates maximum sensitivity.

4.3 TROUBLESHOOTING

4.3.1 General

Most circuits in the Model 6000 Series Accumulators are mounted on printed circuit boards which can be removed and replaced easily. Troubleshooting can be greatly simplified by replacing boards suspected of being faulty with spare boards which are known to be in good working order. Once the faulty board is found, it can be repaired and returned to operation.

4.3.2 Replacing Components on Printed Circuit Boards

To prevent damage to the printed circuit board and its components, use heat sparingly and work carefully. Follow this procedure for removing a defective component.

1) Melt the solder in the component lead holes and tap the board gently to remove solder around component leads.

2) Straighten component leads with long-nose pliers or soldering aid.

3) Remove the defective component.

4) If component cannot be removed, reheat leads slightly.

To install a new component:

1) Clean lead holes thoroughly.

2) Cut and bend component leads to proper length and shape.

3) Insert leads into holes and solder into place.

NOTE

When installing transistors or diodes, use a heat sink to prevent excessive heat conduction through the component. Long-nose pliers applied between the component and the soldering iron make an effective heat sink.

4.3.3 Over-All Troubleshooting

Troubles can often be isolated to an individual circuit board by observing front panel indications in the various operating modes.

When the faulty board has been located, some of the idealized waveforms and voltage levels given in Section 3 may be helpful in locating the exact problem.

PART B

SECTION 1

INTRODUCTION

1.1 GENERAL

The Models 6004 and 6005 are basic Model 6003 type accumulators with the addition of preset capability. The Model 6004 provides single preset capability, whereas the Model 6005 provides dual preset capability.

The basic accumulation process is performed exactly the same as in the Model 6003. All circuit boards present in the Model 6003 are present in the Models 6004 and 6005. The Model 6004 has a single preset board and five-digit preset select switch added to the basic Model 6003. The Model 6005 has two preset boards and two five-digit preset select switches added to the basic Model 6003. Figures 1-1 and 1-2 show the front panel of the Model 6004 Accumulator and Model 6005 Dual Preset Accumulator, respectively.

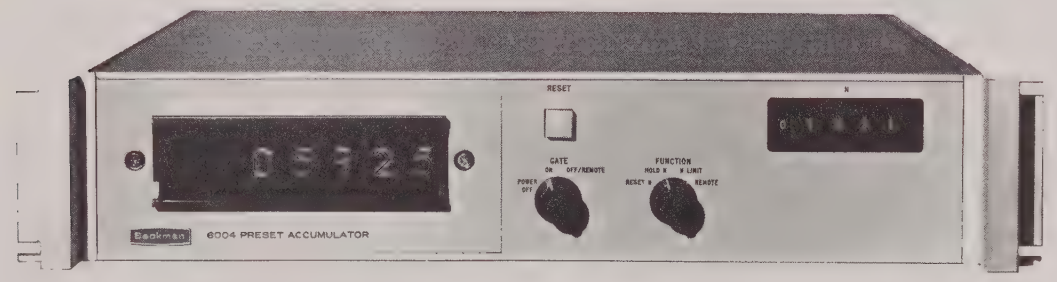


Fig. 1-1. Model 6004 Front Panel

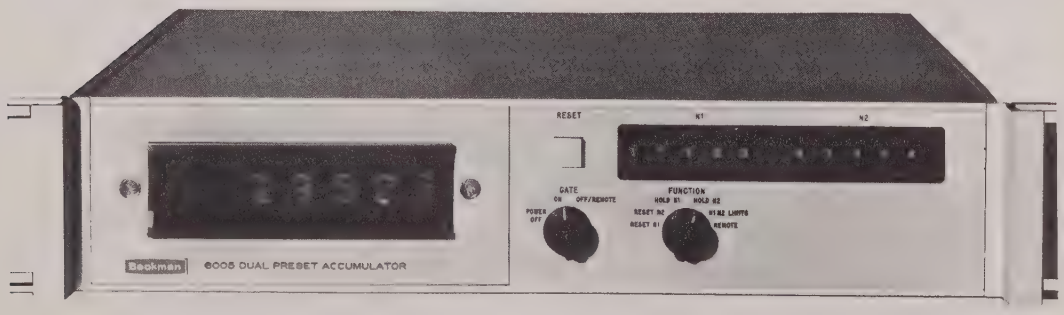


Fig. 1-2. Model 6005 Front Panel

The preset accumulators are basic accumulators which perform a specific function when the accumulator reaches a preset number. The three possible functions are basically as follows:

1) Reset accumulator to zero when the accumulator reaches the preset sum.

2) Inhibit further counting when the preset sum is reached; store and display the preset sum indefinitely.

3) Generate an electrical output when the preset sum is reached; continue uninterrupted counting to 99,999, reset to zero, and continue counting.

1.2 SPECIFICATIONS

Specifications are the same as for the Model 6003. These are listed in Table 1-1, of Part A.

1.3 OPTIONS

Options are listed in Table 1-2 of Part A.

SECTION 2

OPERATION

2.1 GENERAL

Inputs and front panel controls present on the Model 6003 are also present on the Models 6004 and 6005. Model 6004 has an additional output line on which an output signal is generated when the preset limit is reached. Model 6005 has two additional output lines on which output signals are generated when the respective preset limits are reached.

Both instruments have additional controls on the front panel which permit selection of the function to be performed when the accumulator reaches the preset number.

The following information regarding operation of the Model 6003 is also application to both the Models 6004 and 6005. Sections refer to Section 2 of Part A.

1) Applying Power (Section 2.2).

2) Internal Controls (Section 2.4).

2.2 EXTERNAL CONTROLS AND CONNECTORS

Most operating controls are located on the front panel as shown in Figure 2-1 (Model 6004) or Figure 2-2 (Model 6005). The input connector and remote connector are located on the rear panel exactly as in the Model 6003 (shown in Figure 2-2 of Part A).

Table 2-1 explains each control on the front panel. Table 2-2 explains the function of each rear panel connector.

Table 2-1. Front Panel Controls (Models 6004, 6005)

GATE Switch	In ON or OFF/REMOTE, all circuits in the instrument are energized. ON: Count gate is open and the instrument accumulates the X input.

continued. . .

Table 2-1. Front Panel Controls (Models 6004, 6005) - continued

GATE Switch (cont.)	OFF/REMOTE: Gate control is transferred to the remote connector. With Pin 33 grounded, count gate is open. With Pin 33 open circuit, count gate is closed. With the GATE switch in OFF/REMOTE, Pin 32 on the remote connector is at ground.
PRESET Switches	Model 6004: A single set of five thumbwheel switches permits selection of a single preset number, N. Model 6005: Two sets of five thumbwheel switches all permit selection of two preset numbers, N_1 and N_2.
FUNCTION Selector Model 6004:	This is a four-position rotary switch. When the accumulated sum reaches the preset number, the following functions are performed depending on the selected function: a) RESET N: Resets to zero and continues to accumulate; accumulation is uninterrupted. An electrical signal having 100 nanosecond duration is generated at instant of reset. Signal appears on Pin 7 of remote connector. b) HOLD N: Accumulator stops counting. The preset sum is stored and displayed until instrument is reset. An output level appears on Pin 7 of the remote connector at the instant the preset number is reached and remains until reset to zero. c) N LIMIT: An electrical step output appears on Pin 7 of remote connector. The level remains until the instrument is reset. Counting is uninterrupted. d) REMOTE: Function is selected with contact closures to ground on remote connector. Pin 9 on remote connector becomes ground. 1) RESET N: Ground Pin 11. 2) HOLD N: Ground Pin 10. 3) N LIMIT: Both Pins 10 and 11 are kept open.

continued. . .

Table 2-1. Front Panel Controls (Models 6004, 6005) - continued

FUNCTION Selector Model 6005:	The FUNCTION selector is a six-position rotary switch. When the accumulated sum reaches a preset number, the following functions are performed: a) RESET N_1: When accumulated sum reaches N_1, the instrument resets to zero and continues to accumulate, uninterrupted. At instant of reset, an electrical signal having 100 nanosecond duration is Generated. Signal appears on Pin 7 of remote connector. b) RESET N_2: The function described for RESET N_1 is performed when the accumulated sum reaches N_2. The output signal appears on Pin 6 of remote connector. c) HOLD N_1: When accumulated sum reaches N_1, accumulator stops counting. The preset sum is stored and displayed until instrument is reset. An output level appears on Pin 7 of remote connector at the instant the preset number is reached and remains until reset to zero. d) HOLD N_2: The function described for HOLD N_1 is performed when the accumulated sum reaches N_2. The output level appears on Pin 6 of remote connector. e) N_1 N_2 LIMITS: Electrical step outputs are generated when accumulator reaches N_1 and N_2. These levels remain until the instrument is reset to zero. The N_1 output level appears on Pin 7 while the N_2 output level appears on Pin 6 of remote connector. Counting is uninterrupted. f) REMOTE: Function is selected with contact closure to ground on remote connector. Pin 9 on remote connector becomes ground. 1) RESET N_1: Ground Pin 11. 2) RESET N_2: Ground Pin 13. 3) HOLD N_1: Ground Pin 10. 4) HOLD N_2: Ground Pin 12. 5) N_1 N_2 LIMITS: Pins 10, 11, 12, and 13 are kept OPEN.

Table 2-2. Rear Panel Connectors

X INPUT, J1 (Type BNC)	X data is applied at this connector.
Remote Connector, J2 (36-Pin Amphenol 57-40360)	Provides remote selection of GATE condition, FUNCTION, slope and remote reset. Preset N outputs also appear on remote connector.

Table 2-3. Models 6004 and 6005 Remote Connector Pin Numbers

Pin Number	Function	Pin Number	Function
1	X-Slope Select	19	*
2	Ground	20	*
3	*	21	*
4	*	22	*
5	*	23	*
6	(N_2 Output)	24	(Ground - twisted with 6)
7	N_1 Output	25	(Ground - twisted with 7)
8	*	26	*
9	Ground when FUNCTION is REMOTE	27	*
10	HOLD N_1 FUNCTION	28	*
11	RESET N_1 FUNCTION	29	*
12	(HOLD N_2 FUNCTION)	30	*
13	(RESET N_2 FUNCTION)	31	*
14	*	32	Ground when GATE is OFF/REMOTE
15	*	33	GATE ON
16	*	34	*
17	*	35	Ground
18	*	36	Remote Reset

* Not used in standard instrument.

( ) Not used in Model 6004.

SECTION 3

THEORY OF OPERATION

3.1 GENERAL

All operational boards present in the Model 6003 are present in the Models 6004 and 6005. These boards are located in the same positions as in the Model 6003. In addition, the Model 6004 has a single "preset" circuit board while the Model 6005 has two "preset" circuit boards.

3.2 THEORY OF OPERATION OF THE BASIC ACCUMULATOR

The "basic accumulator" portion of the Models 6004 and 6005 (input amplifier, accumulator control, and decimal counting units) is the same as for the Model 6003. Theory of Operation is described in Sections 3-1 to 3-4 of Part A. Block diagrams of the printed circuit boards present in the Models 6004 and 6005 are shown in Figure 3-1, a fold-out page at the end of this section. For a complete interboard wiring diagram, refer to the master wiring diagram included at the back of the manual.

3.3 PRESET

3.3.1 General

The preset boards are used with the Models 6004 and 6005 accumulators. The purpose of this board is to provide either a dc gate or reset trigger signal to the accumulator control whenever the accumulated sum reaches the preset limit. These signals correspond to the FUNCTION switch being in either the HOLD or RESET positions. The LIMIT position on the FUNCTION switch results in neither a gate nor a reset trigger signal from the preset board. Thus the operator can have the accumulator stop counting and hold the sum when the preset limit is reached, automatically reset to zero, or count beyond the preset limit.

The diagram of the inputs and outputs to the preset board is shown in Figuse 3-2. Each input and output is explained below. A logic diagram of preset board operation is shown in Figure 3-3.

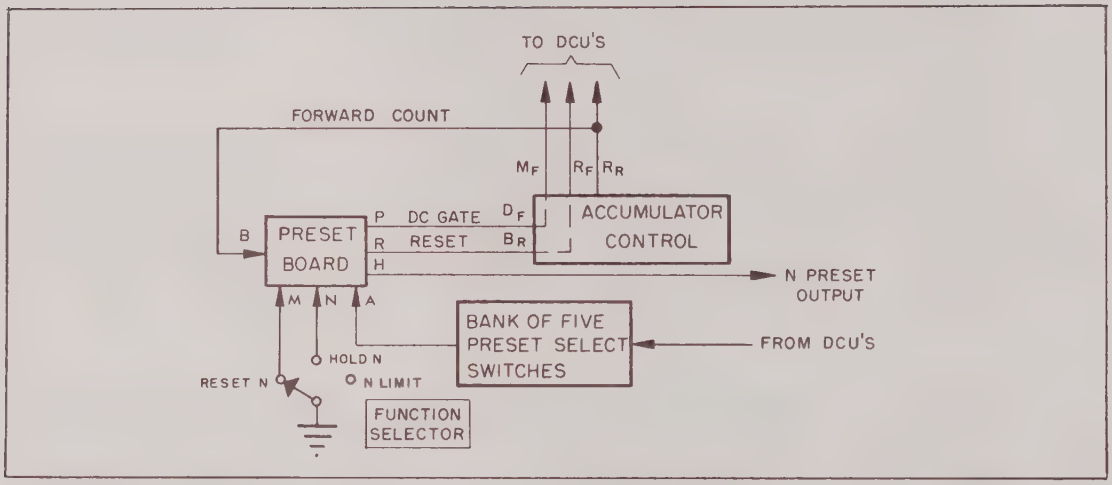


Fig. 3-2. Model 6004 Preset Board Inputs and Outputs. An additional Preset Board is present in Model 6005

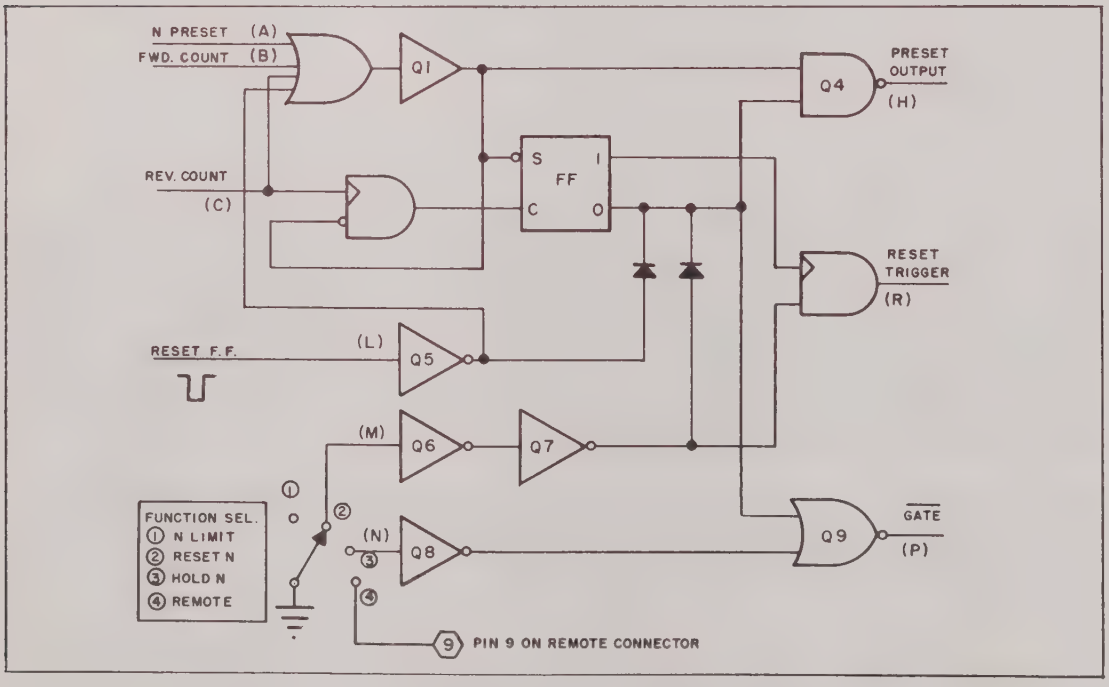


Fig. 3-3. Preset Board Logic Diagram

3.3.2 DCU and Preset Select Switches

The bank of five preset select switches provide a negative-going output pulse (0 to -7 volts) to the preset board whenever the absolute value of the accumulator sum matches the preset number. Each preset switch recognizes the presence of its preset digit in its corresponding DCU simply by the simultaneous appearance of a signal on the correct dual decimal and odd-even lines. For example, Figure 3-4 shows the 10^1 preset switch at "0". When the 10^1 DCU registers "0", negative true signals (0 to -6 volts) appear on H and C. The output dioes in the bank of select switches perform as a negative zone AND gate. (Refer to Appendix, Logic Symbols and Typical Circuits.) Therefore, an output to the preset board will be generated only when all five DCU's simultaneously register their preset decimal digits.

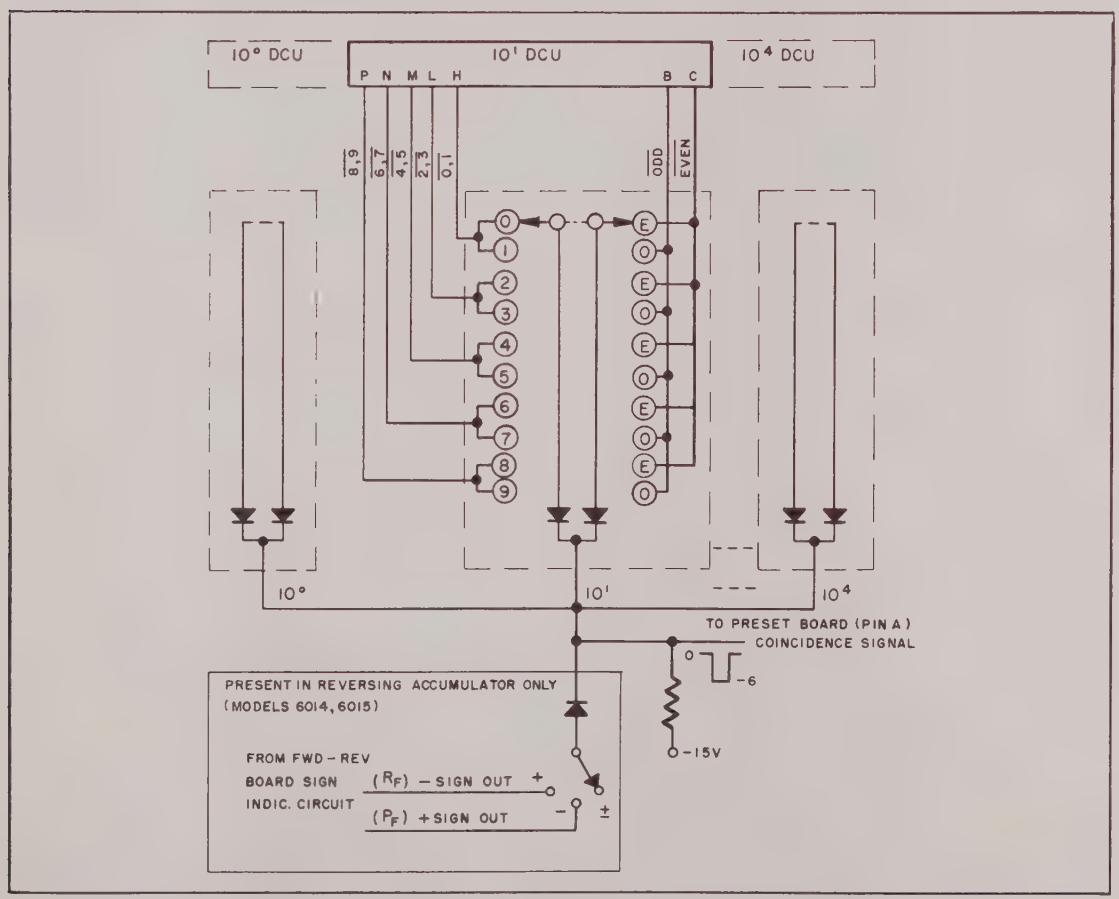
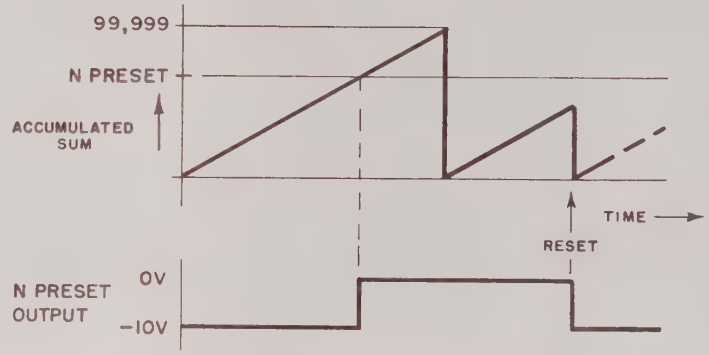
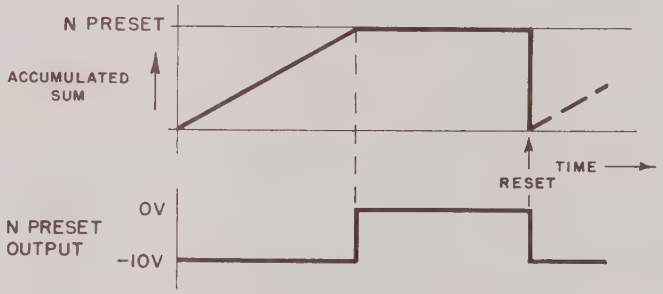


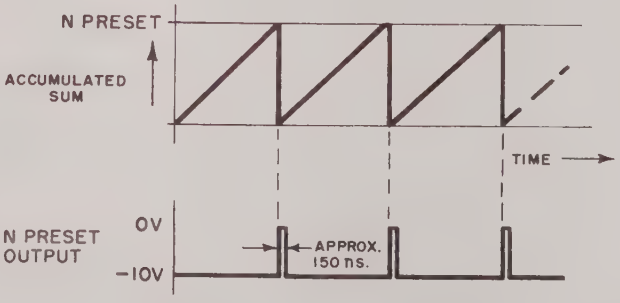
Fig. 3-4. Preset Select Switch Schematic



a) N-Preset Output when FUNCTION Switch is in N-LIMIT Position



b) N-Preset Output when FUNCTION Switch is in HOLD-N Position



c) N-Preset Output when FUNCTION Switch is in RESET-N Position

Fig. 3-5. N-Preset Outputs for Various FUNCTION Switch Settings

3.3.3 Preset N Outputs

With the FUNCTION switch in the N-LIMIT position, the preset board will provide a dc output level (0 volt) whenever the preset limit is exceeded. This dc level remains until the accumulator is reset to zero. It then returns to a negative voltage level (-10 volts). See Figure 3-5a.

With the FUNCTION switch in the HOLD N position, the 0 volt dc level will remain until the accumulator is reset to zero. See Figure 3-5b.

With the FUNCTION switch in the RESET position, the preset board will provide a positive-going signal level (-10 volts to ground) each time the accumulator reaches the preset limit. This signal has a duration of approximately 100 seconds. See Figure 3-5c.

3.3.4 DC Gate and Reset Trigger

The gating signals and reset pulses are triggered with the "0" and "1" output from the flip-flop. This is shown in Figure 3-4. The gating circuits for these two signals are controlled by the FUNCTION selector being in either the HOLD N or RESET N positions, respectively. As shown in Figure 3-4, the FUNCTION selector controls the NOR or AND output gate in the open condition for the GATE or "reset trigger" signal.

Table 3-2. Bi-Quinary Decimal Code

	Binary		Quinary				
Decimal	Q_1	Q_2	Q_7	Q_8	Q_9	Q_{10}	Q_{11}
0	1	0	1	0	0	0	0
1	0	1	1	0	0	0	0
2	1	0	0	1	0	0	0
3	0	1	0	1	0	0	0
4	1	0	0	0	1	0	0
5	0	1	0	0	1	0	0
6	1	0	0	0	0	1	0
7	0	1	0	0	0	1	0
8	1	0	0	0	0	0	1
9	0	1	0	0	0	0	1

Logic "1" (or TRUE) refers to transistor being in OFF state.
Logic "0" (or FALSE) refers to transistor being in ON state.

Going forward from 9 to 0 applies forward count to the next higher order DCU and resets the bi-quinary to decimal zero.

The five quinary outputs together with the EVEN and ODD lines can be combined to provide outputs to the lamp drives. The outputs from Q1 and Q7 enter an AND gate to provide the DCU zero coincidence indication.

3.5.3 Lamp Drives

Sine the ODD and EVEN outputs are the "Common" lines on the lamp blocks, they determine which of the two possible decimal digits are present on the quinary output lines. A typical lamp block DCU interconnection diagram is shown in Figure 3-6.

3.5.4 BCD Outputs (Optional)

Outputs from the "count" transistors can be combined to provide BCD outputs to a recorder. Four output lines are used for all codes and changing from one code to another requires a reassignment of weights to each line and changes in the output circuit.

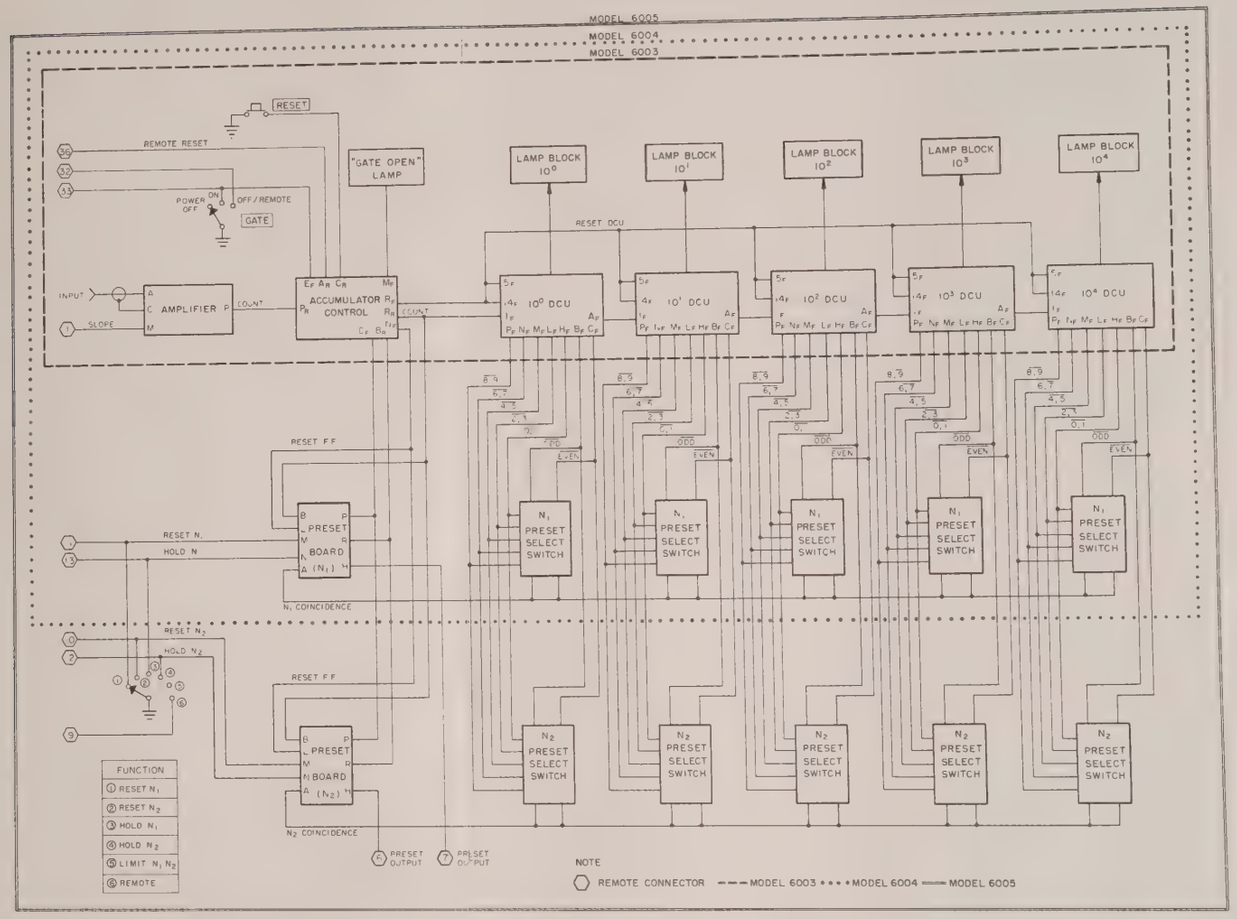


Fig. 3-1. Models 6003, 6004, 6005 Block Diagram

SECTION 4

SERVICING

4.1 GENERAL

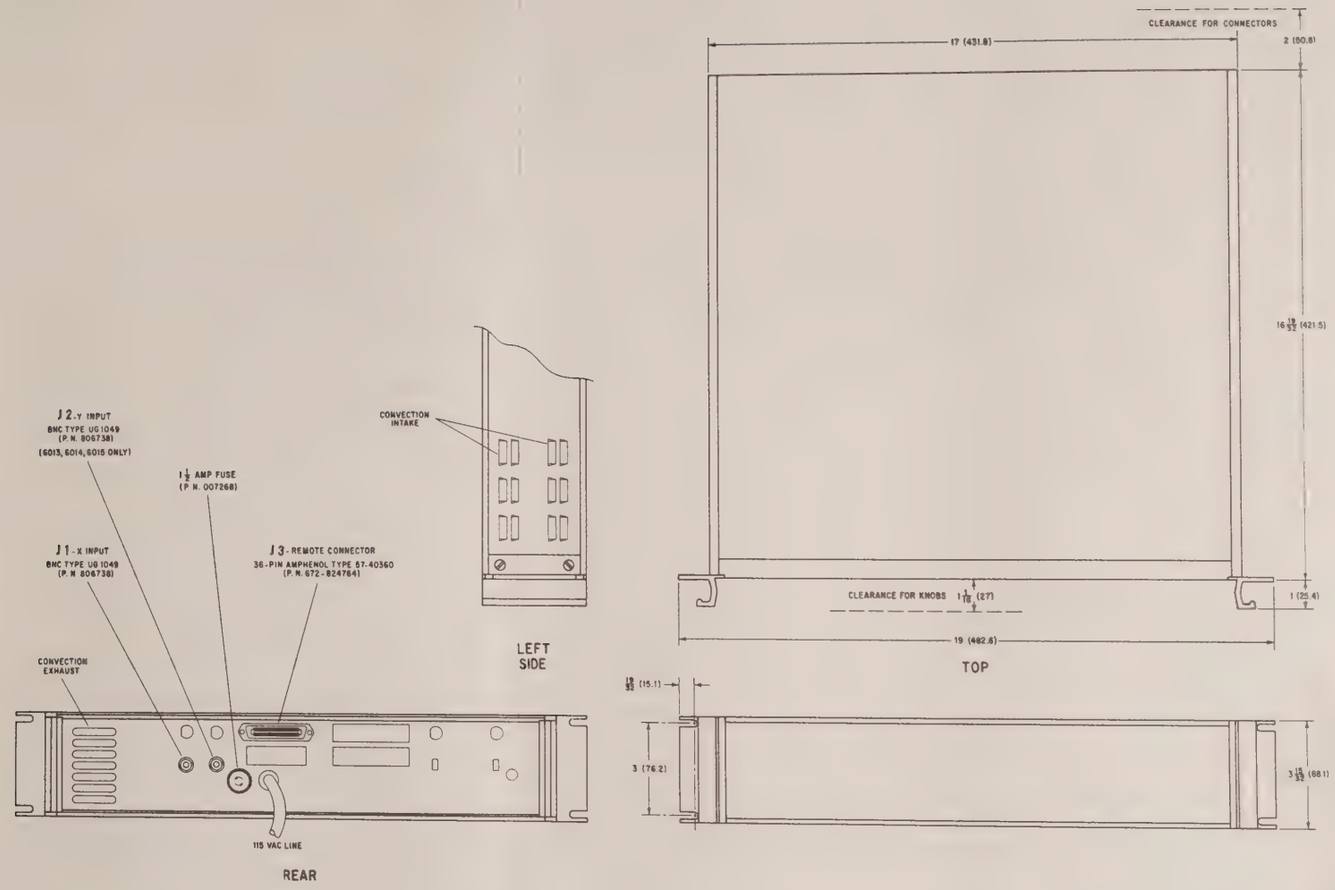
Servicing information for the Models 6004 and 6005 is the same as for the Model 6003. Refer to Section 4, Servicing, Part A.

MISCELLANEOUS PARTS

(Models 6003A, 6004A, 6005A, Outline Drawing)

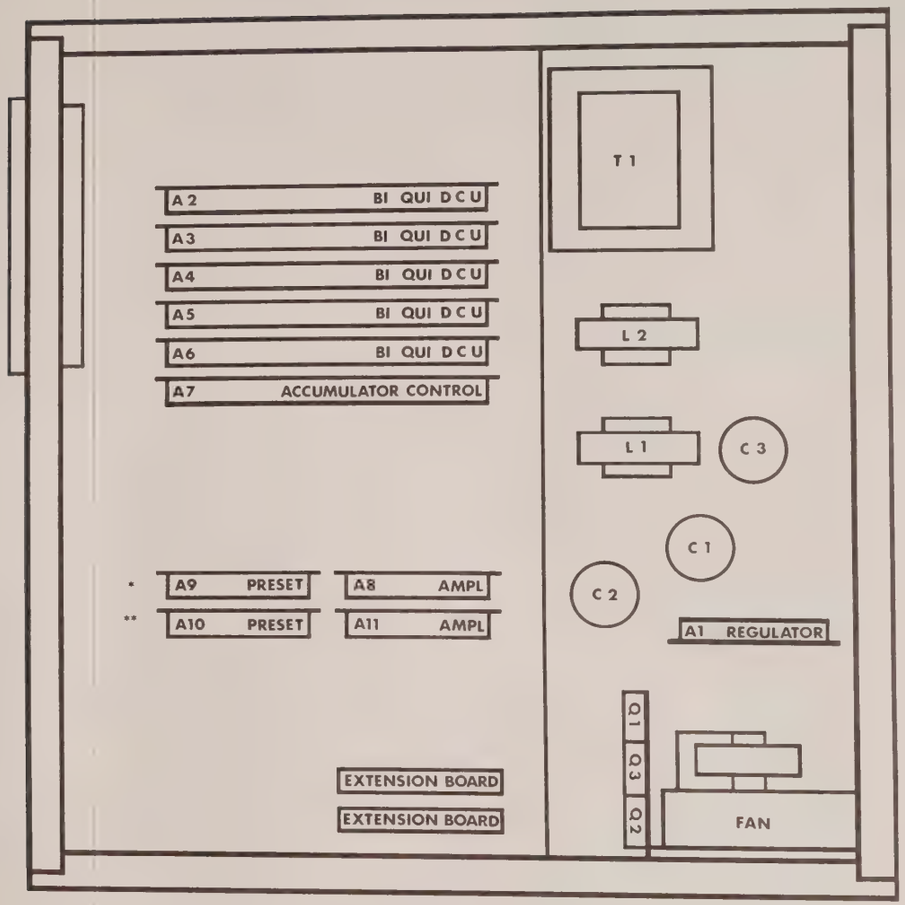
Detail No.	Beckman Part No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
	716-838151	Switch (Reset)	Dialco 513-0101-604	1
	716-838205	Switch (11 Station)	EECO 26SM-11	1
	711-425471	Switch (Gate)	Beckman	1
	716-838203	Switch Spacer	EECO S26SM	1
	711-425917	Switch (Function) (6004A & 6005A)	Beckman	1
	711-837930	Switch	EECO 025699	10
	716-838152	Reset Lens Cap. Ass'y	Dialco 185-18-75	1
	325-420982	Knob	Beckman	2
	330-420770	Handle	Beckman	2
	680-424115	P.C. Board Connectors (Dual)	Beckman	10
	680-823481	P.C. Board Connectors (Single)	Cinch	7
P3	672-824765	Connector	Cinch 57-30360	1
J1	670-806738	Connector	Canon UG-1094U	1
	755-420893	Diode	Beckman	20
J3	672-824764	Connector	Cinch 57-40360	1
	664-812450	Line Cord	Cornish	1
XF1	735-007268	Fuse Holder	Bussman HKP	1
F1	731-801567	Fuse (1.5 Amp, SloBlo)	Littelfuse MDL 313	1
	885-431044	Resistor Module	Beckman	5
	824-834669	Lamp, Plug-In	Eldema CF2-CC-1762	1
	825-841521	Photo-tube	Spectral	5

OUTLINE DRAWING

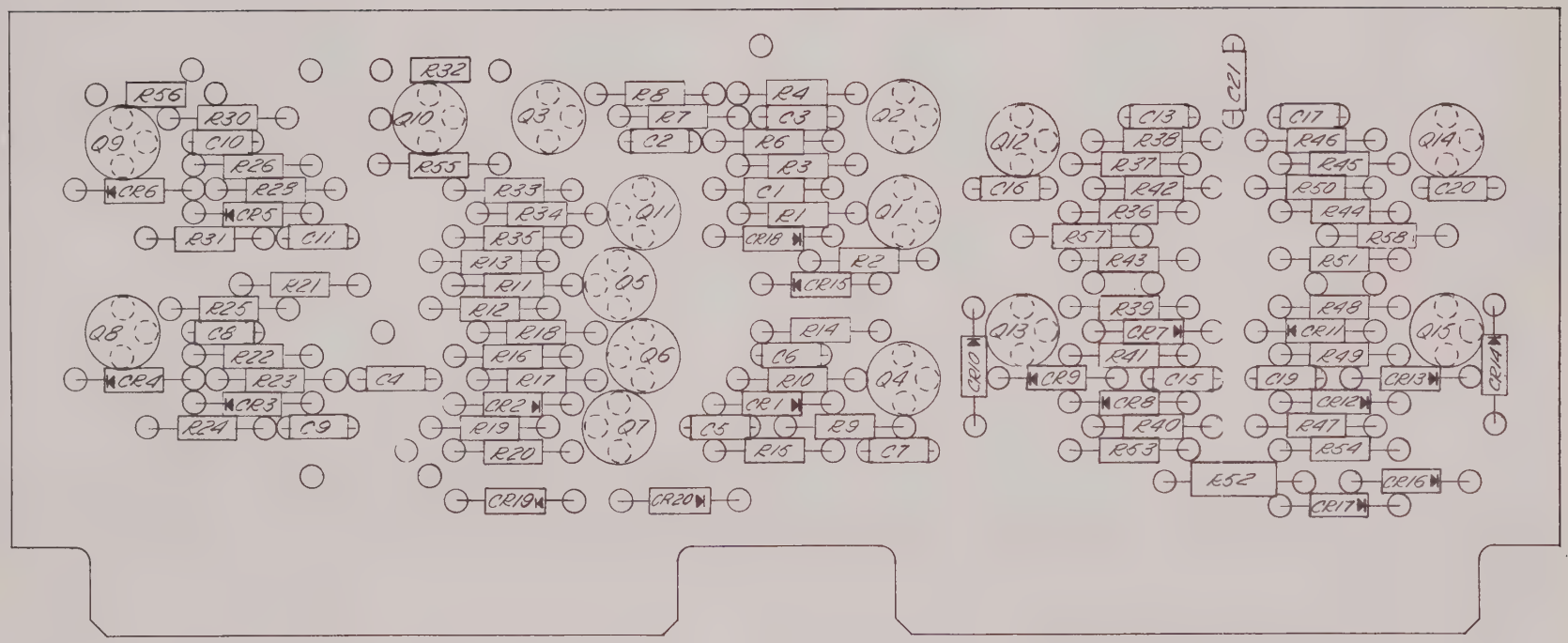


6003A, 04A, 05A
65-C-6000-001-Rev. A
April 1967

Beckman



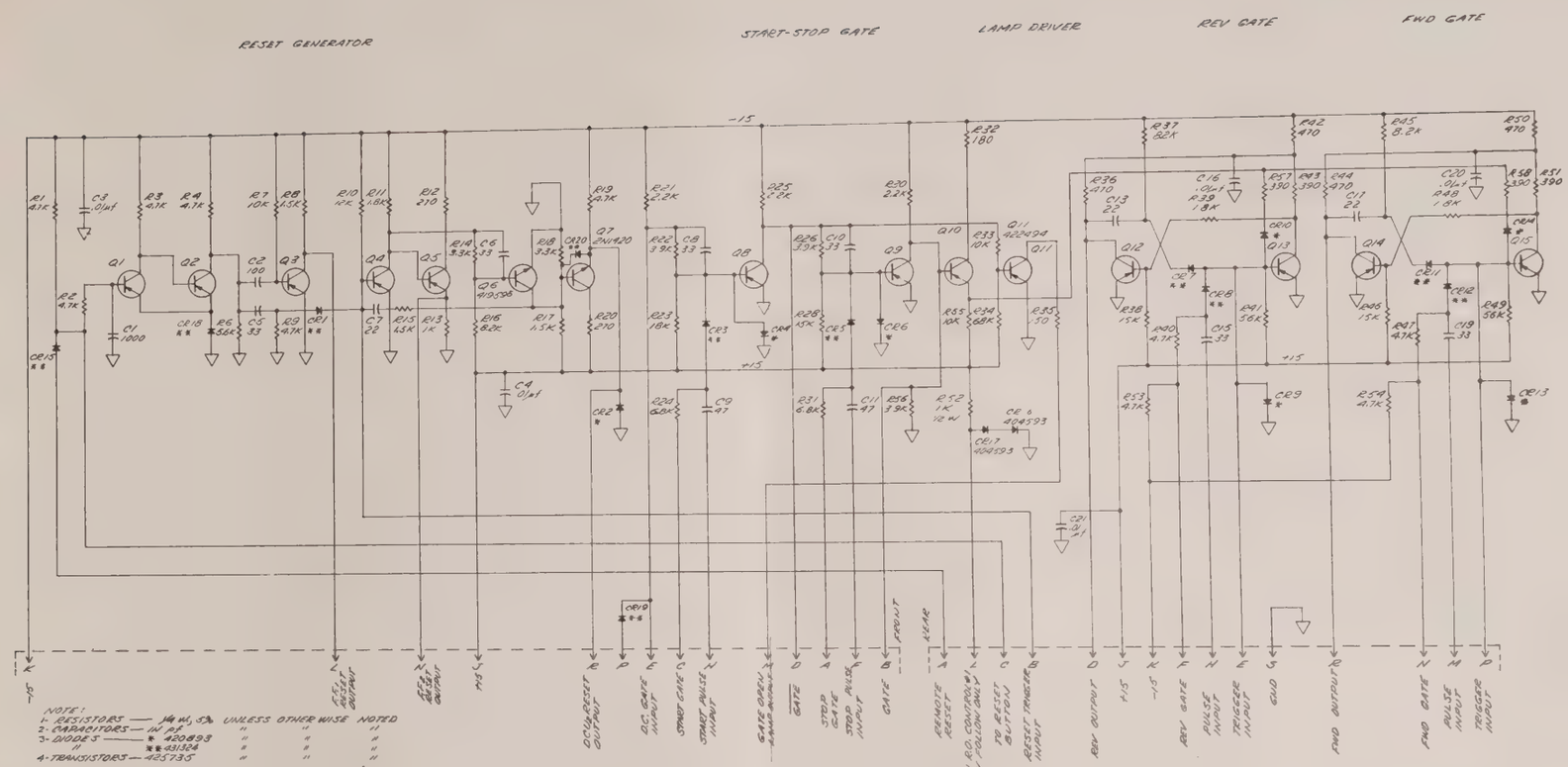
*Models 6004A and 6005A Only.
**Model 6005A Only.

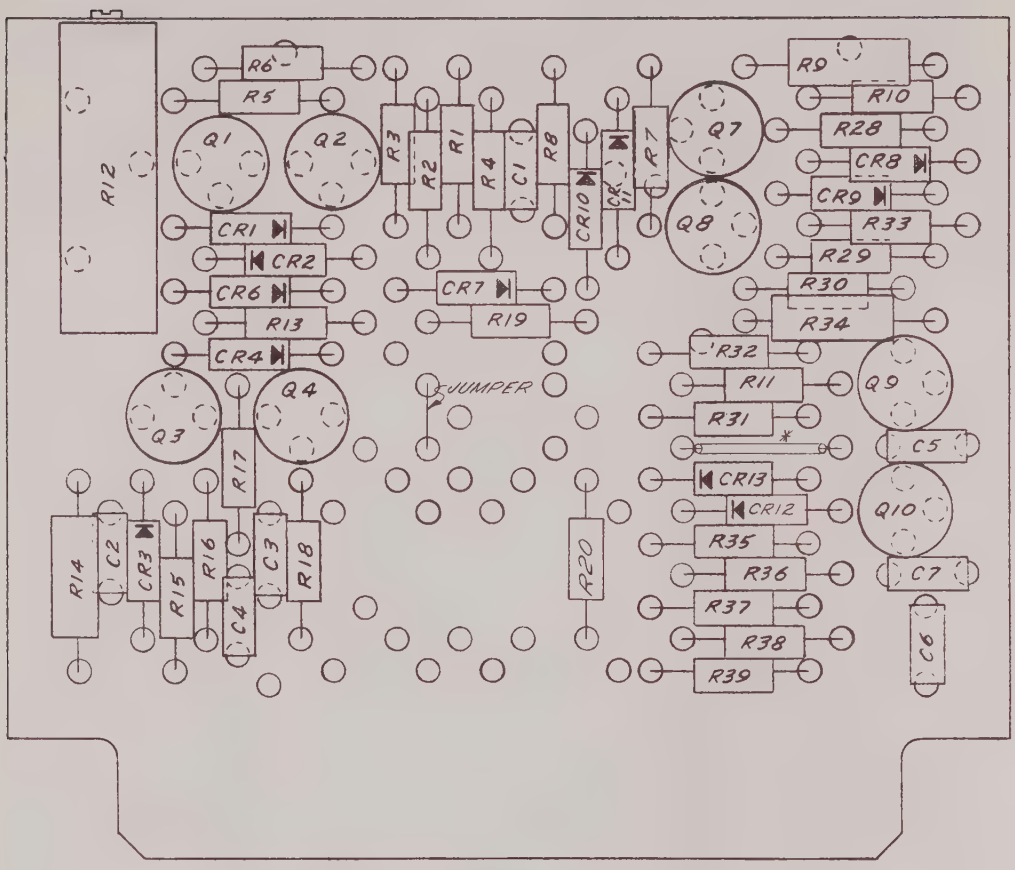


ACCUMULATOR CONTROL BOARD COMPONENT LAYOUT (A7)

ACCUMULATOR CONTROL BOARD (A7)

Detail No.	Beckman Part No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
A7	887-425470 (G)	Accumulator Control Board	Beckman	1
C1	637-824028	Cap. 1000pf, 300V, 5%	Elmenco DM16E102J-300	1
C2	633-836932	Cap. 100pf, 500V, 10%	Skottie TSD-4-101-K	1
C3, 4, 16, 20, 21,	633-804715	Cap..01μf. 50V	Sprague 19C214	5
C5, 6, 8, 10, 15, 19	633-838426	Cap. 33pf. 500V, 10%	Skottie TSD-4-330-K	6
C7, 13, 17	633-838425	Cap. 22pf, 500V, 10%	Skottie TSD-4-220-K	3
C9, 11	633-839568	Cap. 47pf, 500V, 10%	Skottie TSD-4-470K-1/2	2
CR1, 3, 5, 7, 8, 11, 12, 15, 18, 19, 20	755-431324	Diode, Special	Beckman	11
CR2, 4, 6, 9, 10, 13, 14	755-420893	Diode, Special "893"	Beckman	7
CR16, 17	755-404593	Diode, Special	Beckman	2
Q1, 2, 3, 4, 5, 8, 9, 10, 12, 13, 14, 15	755-425735	Transistor, Special	Beckman	12
Q6	755-419596	Transistor, Special	Beckman	1
Q7	755-817964	Transistor, 2N1420	Pacific Semiconductor	1
Q11	755-422494	Transistor, Special	Beckman	1
R1, 2, 3, 4, 9, 19, 40, 47, 53, 54	601-822297	Resistor, 4.7K, 1/4W, 5%	Allen Bradley CB4725	10
R6	601-823397	Resistor, 5.6K, 1/4W, 5%	Allen Bradley CB5625	1
R7, 33, 55	601-822324	Resistor, 10K, 1/4W, 5%	Allen Bradley CB1035	3
R8, 15, 17	601-822527	Resistor, 1.5K, 1/4W, 5%	Allen Bradley CB1525	3
R10	601-801803	Resistor, 12K, 1/4W, 5%	Allen Bradley CB1235	1
R11, 39, 48	601-822544	Resistor, 1.8 K, 1/4W, 5%	Allen Bradley CB1825	3
R12, 20	601-823393	Resistor, 270Ω, 1/4W, 5%	Allen Bradley CB2745	2
R13	601-822308	Resistor, 1K, 1/4W, 5%	Allen Bradley CB1025	1
R14, 18	601-822296	Resistor, 3.3K, 1/4W, 5%	Allen Bradley CB3325	2
R16, 37, 45	601-822331	Resistor, 8.2K, 1/4W, 5%	Allen Bradley CB8225	3
R21, 25, 30	601-822328	Resistor, 2.2K, 1/4W, 5%	Allen Bradley CB2225	3
R22, 26, 56	601-822460	Resistor, 3.9K, 1/4W, 5%	Allen Bradley CB3925	3
R23	601-822303	Resistor, 18K, 1/4W, 5%	Allen Bradley CB1835	1
R24, 31	601-822299	Resistor, 6.8K, 1/4W, 5%	Allen Bradley CB6825	2
R28, 38, 46	601-822301	Resistor, 15K, 1/4W, 5%	Allen Bradley CB1535	3
R32	601-823392	Resistor, 180Ω, 1/4W, 5%	Allen Bradley CB1815	1
R34	601-822798	Resistor, 68K, 1/4W, 5%	Allen Bradley CB6805	1
R35	601-823391	Resistor, 150Ω, 1/4W, 5%	Allen Bradley CB1515	1
R36, 42, 44, 50,	601-823395	Resistor, 470Ω, 1/4W, 5%	Allen Bradley CB4715	4
R41, 49	601-823903	Resistor, 56K, 1/4W, 5%	Allen Bradley CB5635	2
R 43, 51, 57, 58,	601-822371	Resistor, 390Ω, 1/4W, 5%	Allen Bradley CB3915	4
R52	601-015038	Resistor, 1K, 1/2W, 5%	Allen Bradley EB1025	1

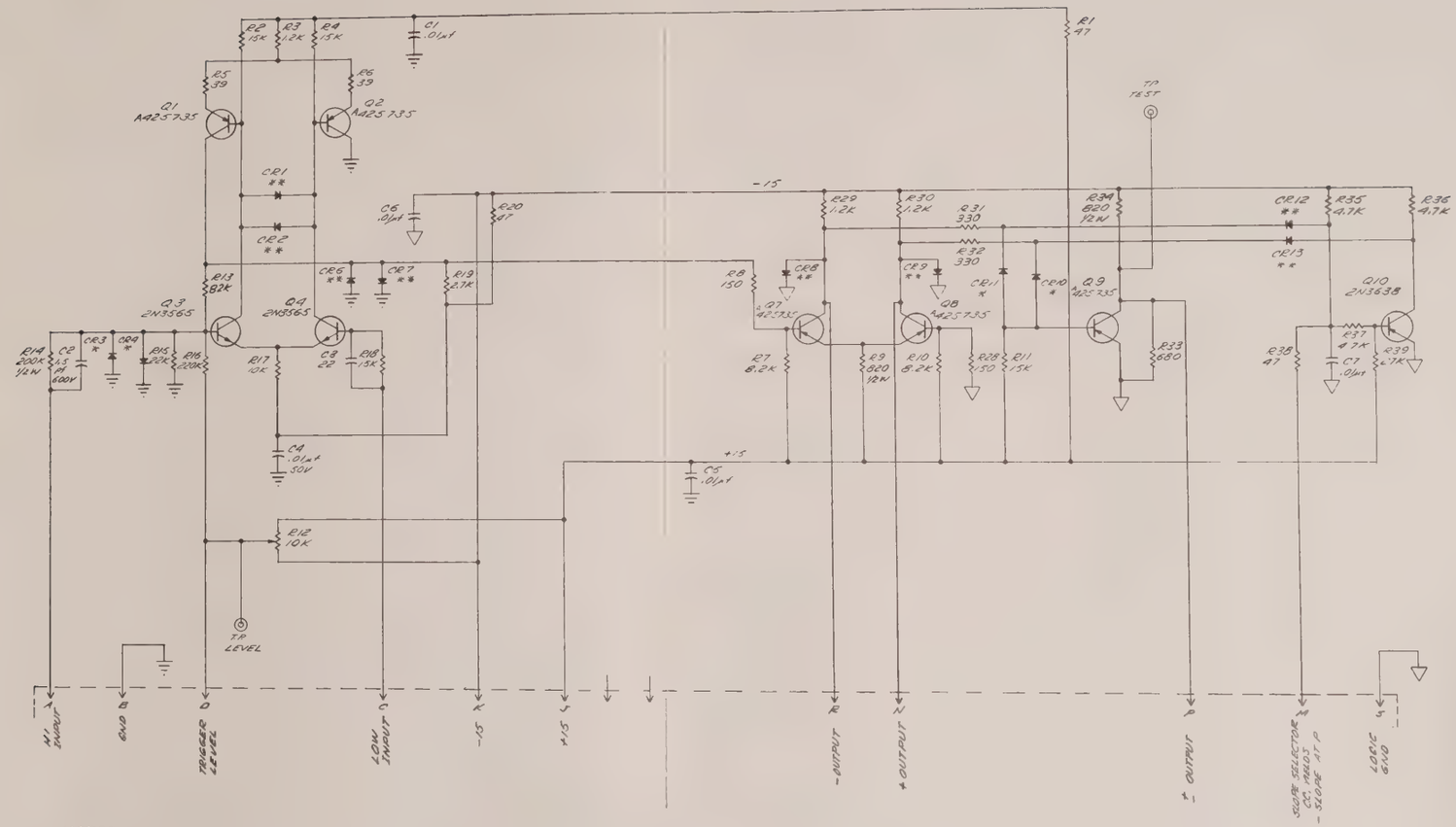

RESET GENERATOR
START-STOP GATE
LAMP DRIVER
REV GATE
FWD GATE
-15
+15
NOTE:
1- RESISTORS — 1/4 W, 5% UNLESS OTHERWISE NOTED
2- CAPACITORS — 1W PC
3- DIODES — * 420893
** 431324
4- TRANSISTORS — 425735
RESET OUTPUT
DC GATE INPUT
START PULSE INPUT
GATE OPEN INPUT
STOP GATE INPUT
GATE OUTPUT
REMOTE RESET
LOCK OUT CONTROL INPUT
RESET TRIGGER INPUT
REV OUTPUT
REV GATE
PULSE INPUT
TRIGGER INPUT
GND
FWD GATE
PULSE INPUT
TRIGGER INPUT



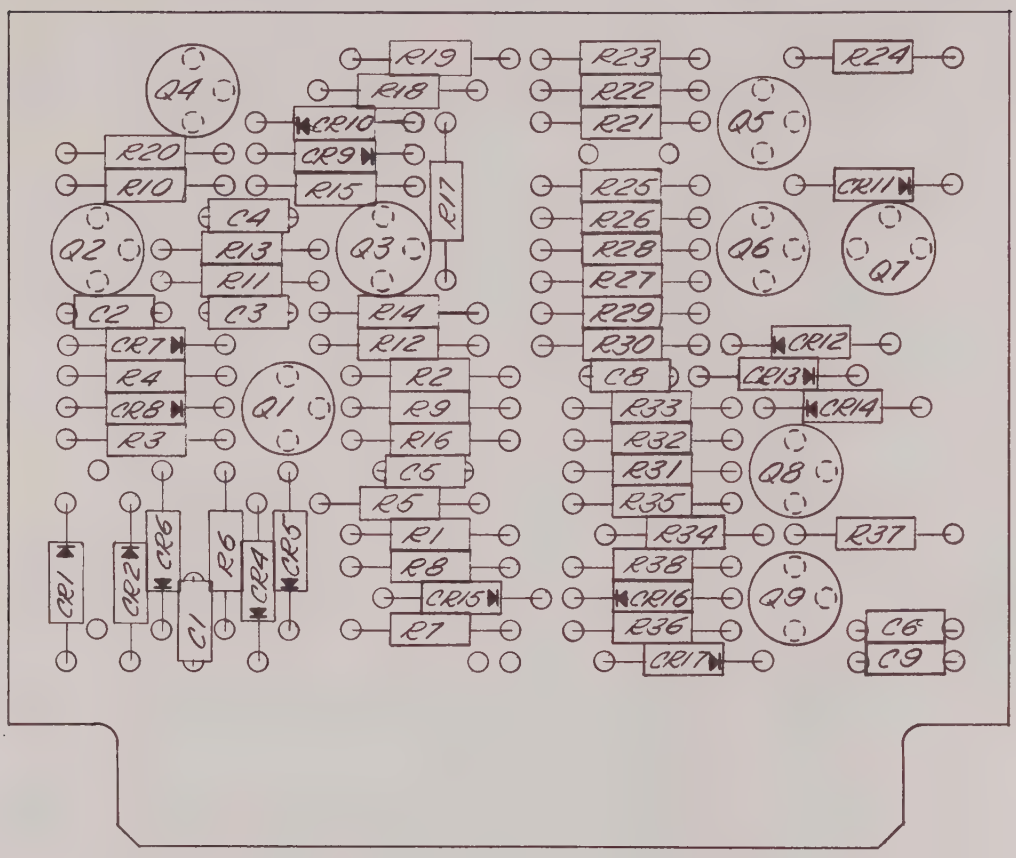
INPUT AMPLIFIER BOARD COMPONENT LAYOUT (A8, A11)

INPUT AMPLIFIER BOARD (A8, A11)

Detail No.	Beckman Part No.	Description	Typical Manufacturer & No.	Qty./ Assy.
A8	887-425611(F)	Input Amplifier Board	Beckman	1
C1, 4, 5, 6, 7	633-804715	Capacitor, F. Ceramic, 0.01μf, 50V	Sprague 19C214	5
C2	633-811294	Capacitor, F. Mica, 1.5pf, 600V	Skottie TCD-4-NPO	1
C3	633-838425	Capacitor, F. Ceramic, 22pf, 500V	Skottie TCD-4-NPO	1
CR1, 2, 6, 7, 8 9, 12, 13	755-420893	Diode, 893	Beckman	8
CR3, 4, 10, 11	755-431324	Diode, Special	Beckman	4
Q1, 2, 7, 8, 9	755-425735	Transistor, Special	Beckman	5
Q3, 4	755-838784	Transistor, Type 2N3565	Fairchild	2
Q10	755-838105	Transistor, Type 2N3638	Fairchild	1
R1, 20, 38	601-823387	Resistor, F. Comp., 47Ω, 1/4W, 5%	Allen Bradley CB4705	3
R2, 4, 11, 18	601-822301	Resistor, F. Comp., 15K, 1/4W, 5%	Allen Bradley CB1535	4
R3, 29, 30	601-822326	Resistor, F. Comp., 1.2K, 1/4W, 5%	Allen Bradley CB1225	3
R5, 6	601-823386	Resistor, F. Comp., 39Ω, 1/4W, 5%	Allen Bradley CB3905	2
R7, 10	601-822331	Resistor, F. Comp., 8.2K, 1/4W, 5%	Allen Bradley CB8225	2
R8, 28	601-823391	Resistor, F. Comp., 150Ω, 1/4W, 5%	Allen Bradley CB1515	2
R9, 34	601-079172	Resistor, F. Comp., 820Ω, 1/2W, 5%	Allen Bradley EB8215	2
R12	611-826874	Resistor, Var., W.W., 10K	Bourns 3067P-1-103	1
R13	601-822543	Resistor, F. Comp., 82K, 1/4W, 5%	Allen Bradley CB8235	1
R14	601-015082	Resistor, F. Comp., 200K, 1/2W, 5%	Allen Bradley EB2045	1
R15	601-822334	Resistor, F. Comp., 22K, 1/4W, 5%	Allen Bradley CB2235	1
R16	601-823908	Resistor, F. Comp., 220K, 1/4W, 5%	Allen Bradley CB2245	1
R17	601-822324	Resistor, F. Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	1
R19	601-822295	Resistor, F. Comp., 2.7K, 1/4W, 5%	Allen Bradley CB2725	1
R31, 32	601-823394	Resistor, F. Comp., 330Ω, 1/4W, 5%	Allen Bradley CB3315	2
R33	601-822369	Resistor, F. Comp., 680Ω, 1/4W, 5%	Allen Bradley CB6815	1
R35, 36, 37	601-822297	Resistor, F. Comp., 4.7K, 1/4W, 5%	Allen Bradley CB4725	3
R39	601-822335	Resistor, F. Comp., 27K, 1/4W, 5%	Allen Bradley CB2735	1



NOTE:
1. RESISTORS: 1/4 W, 5% UNLESS OTHERWISE NOTED.
2. *-DIODES ARE BII A755-431324.
3. **-DIODES ARE BII A755-420893.

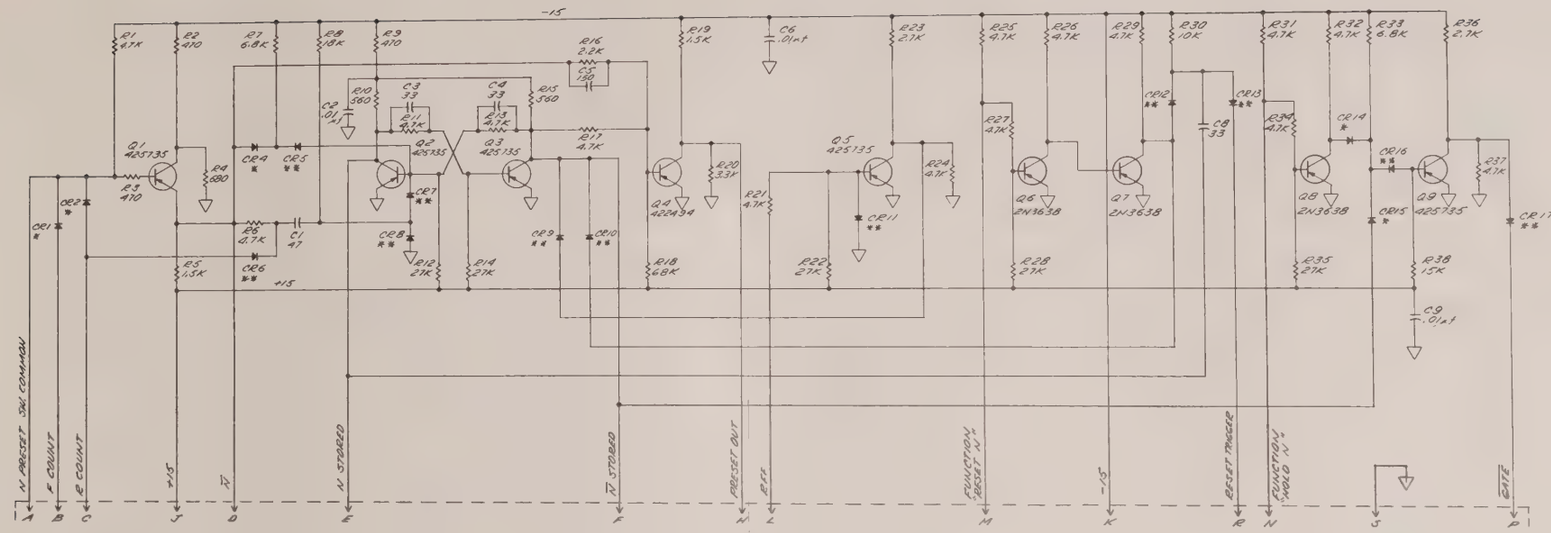


PRESET BOARD COMPONENT LAYOUT (A9, A10)

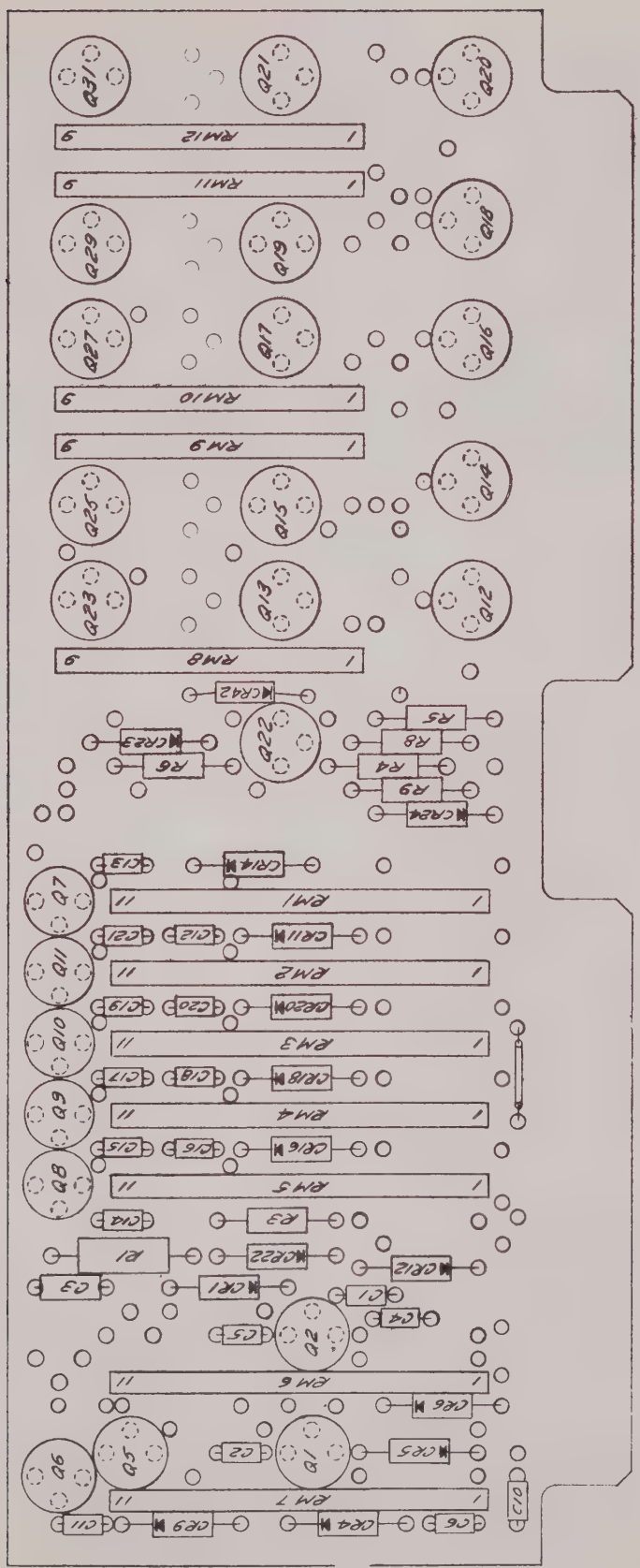
PRESET BOARD (A9, A10)

(Models 6004A, 6005A)

Detail No.	Beckman Part No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
A9	887-426025(D)	Preset Board - Model 6004A (A9) Model 6005A (A9, A10)	Beckman Beckman	1 2
C1	633-839568	Cap., 47pf, 500V, 10%	Skottie TSD4-470K	1
C2, 6, 9	633-836864	Cap., 0.01 μf, 50V	Sprague 19C214A6	3
C3, 4, 8	633-838426	Cap., 33pf, 500V, 10%	Skottie TSD4-330K	3
C5	633-836931	Cap., 150pf, 500V, 10%	Skottie TSD-4-151K	1
CR1, 2, 4, 14, 15	755-420893	Diode, Special	Beckman	5
CR5, 6, 7, 8, 9, 10, 11, 12, 13, 16, 17	755-815561	Diode, 1N3064 (CD6111)	Continental Device	11
Q1, 2, 3, 5, 9	755-425735	Transistor, Special	Beckman	5
Q4	755-422494	Transistor, Special	Beckman	1
Q6, 7, 8	755-838105	Transistor, 2N3638	Fairchild	3
R1, 6, 11, 13, 17, 21, 24, 25, 26, 27, 29, 31, 32, 34, 37	601-822297	Resistor, F.Comp., 4.7K, 1/4W, 5%	Allen Bradley CB4725	15
R2, 3, 9	601-823395	Resistor, F.Comp., 470Ω, 1/4W, 5%	Allen Bradley CB4715	3
R4	601-822369	Resistor, F.Comp., 680Ω, 1/4W, 5%	Allen Bradley CB6815	1
R5, 19	601-822527	Resistor, F.Comp., 1.5K, 1/4W, 5%	Allen Bradley CB1525	2
R7, 33	601-822299	Resistor, F.Comp., 6.8K, 1/4W, 5%	Allen Bradley CB6825	2
R8	601-822303	Resistor, F.Comp., 18K, 1/4W, 5%	Allen Bradley CB1835	1
R10, 15	601-823396	Resistor, F.Comp., 560Ω, 1/4W, 5%	Allen Bradley CB5615	2
R12, 14, 22, 28, 35	601-822335	Resistor, F.Comp., 27K, 1/4W, 5%	Allen Bradley CB2735	5
R16	601-822328	Resistor, F.Comp., 2.2K, 1/4W, 5%	Allen Bradley CB2225	1
R18	601-822798	Resistor, F.Comp., 68K, 1/4W, 5%	Allen Bradley CB6835	1
R20	601-822296	Resistor, F.Comp., 3.3K, 1/4W, 5%	Allen Bradley CB3325	1
R23, 36	601-822295	Resistor, F.Comp., 2.7K, 1/4W, 5%	Allen Bradley CB2725	2
R30	601-822324	Resistor, F.Comp., 10K, 1/4W, 5%	Allen Bradley CB1035	1
R38	601-822301	Resistor, F.Comp., 15K, 1/4W, 5%	Allen Bradley CB1535	1



NOTES:
RESISTORS —— ¼ W, 5% UNLESS OTHERWISE NOTED.
CAPACITORS —— IN pf " " "
DIODES * —— 420893
" ** —— 1N3064



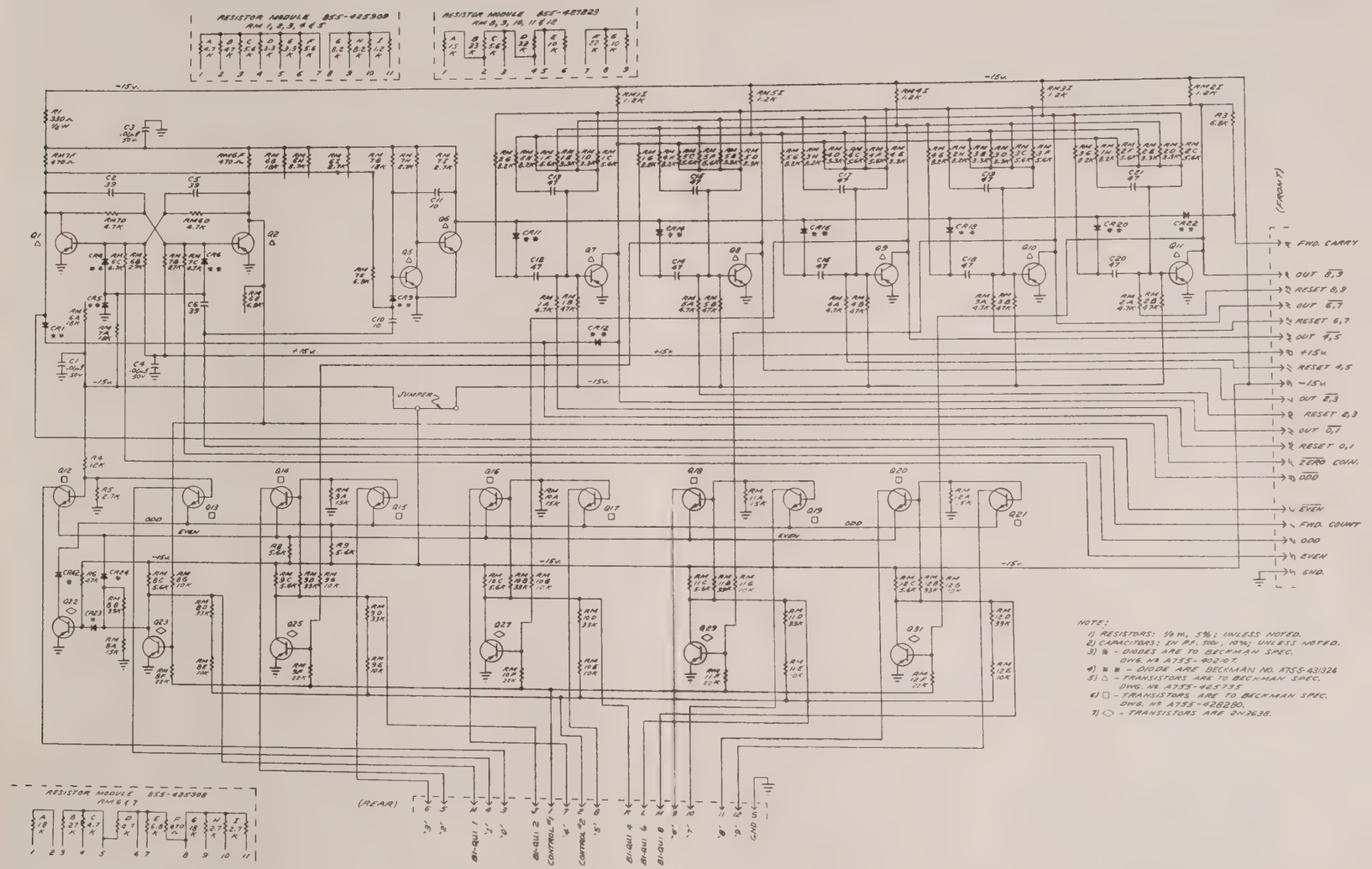
FORWARD DCU W/GLO-TUBE READOUT BOARD
COMPONENT LAYOUT (A2 thru A6)

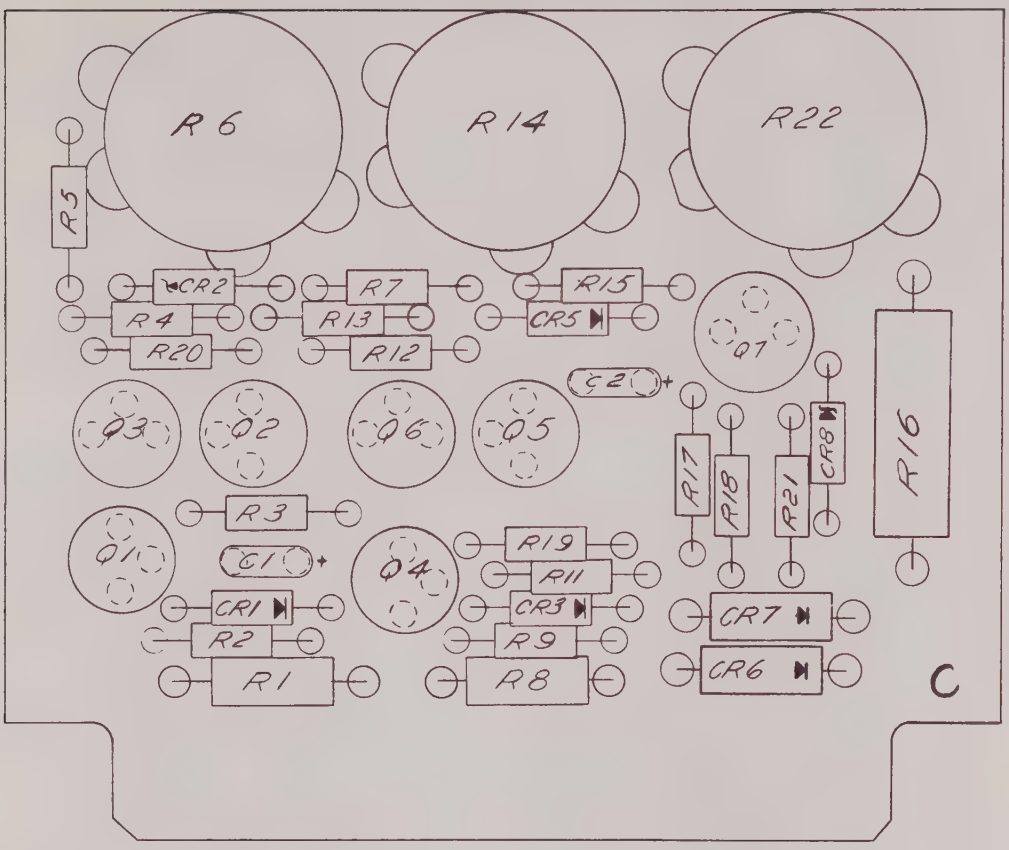
FORWARD DCU W/GLO-TUBE READOUT (A2 THRU A6)

(Models 6003A, 6004A, 6005A)

Detail No.	Beckman Part No.	Description	Typical Manufacturer & No	Qty./ Ass'y
A2 Thru A6	887-427792 (C)	FWD DCU w/Glo-Tube R.O.	Beckman	5
C1, 3, 4	633-836864	Capacitor, F.Cerm., 0.01 μf 50V	Sprague 19C214A6	3
C2, 5, 6	633-839570	Capacitor, F.Cerm., 39pf, 500V, 10%	Skottie TSD 4-300-K	3
C10, 11	633-839569	Capacitor, F. Cerm., 10pf, 500V, 10%	Skottie TSD 4-100-K	2
C12 thru C21	633-839568	Capacitor, F. Cerm., 47pf, 500V, 10%	Skottie TSD 4-470-K	10
CR1, 4, 5, 6, 9, 11, 12, 14, 16, 18, 20, 22	755-431324	Diode, Silicon	Beckman	12
CR23, 24, 42	755-402107	Diode, Silicon, Special	Beckman	3
Q1, 2, 5, 6, 7, 8, 9, 10, 11	755-425735	Transistor, Special	Beckman	9
Q12 thru Q21	755-428280	Transistor, Special	Beckman	10
Q22, 23, 25, 27, 29, 31	755-838105	Transistor, 2N3638	Fairchild	6
R1	601-015443	Resistor, F.Comp., 330Ω, 1/2W, 5%	Allen Bradley EB3315	1
R3	601-822299	Resistor, F.Comp., 6.8K, 1/4W, 5%	Allen Bradley CB6825	1
R4	601-822333	Resistor, F.Comp., 12K, 1/4W, 5%	Allen Bradley CB1235	1
R5	601-822295	Resistor, F.Comp., 2.7K, 1/4W, 5%	Allen Bradley CB2725	1
R6	601-823902	Resistor, F.Comp., 47K, 1/4W, 5%	Allen Bradley CB4735	1
R8, 9	601-822397	Resistor, F.Comp., 5.6K 1/4W, 5%	Allen Bradley CB5625	2
RM1 thru RM5	885-425909	Resistor Module	Beckman	5
RM6, 7	885-425908	Resistor Module	Beckman	2
RM8 thru RM12	885-427223	Resistor Module	Beckman	5
	864-811098	Transistor pad	Milton Ross 10099	16

FORWARD DCU
W/GLO-TUBE READOUT
SCHEMATIC DIAGRAM

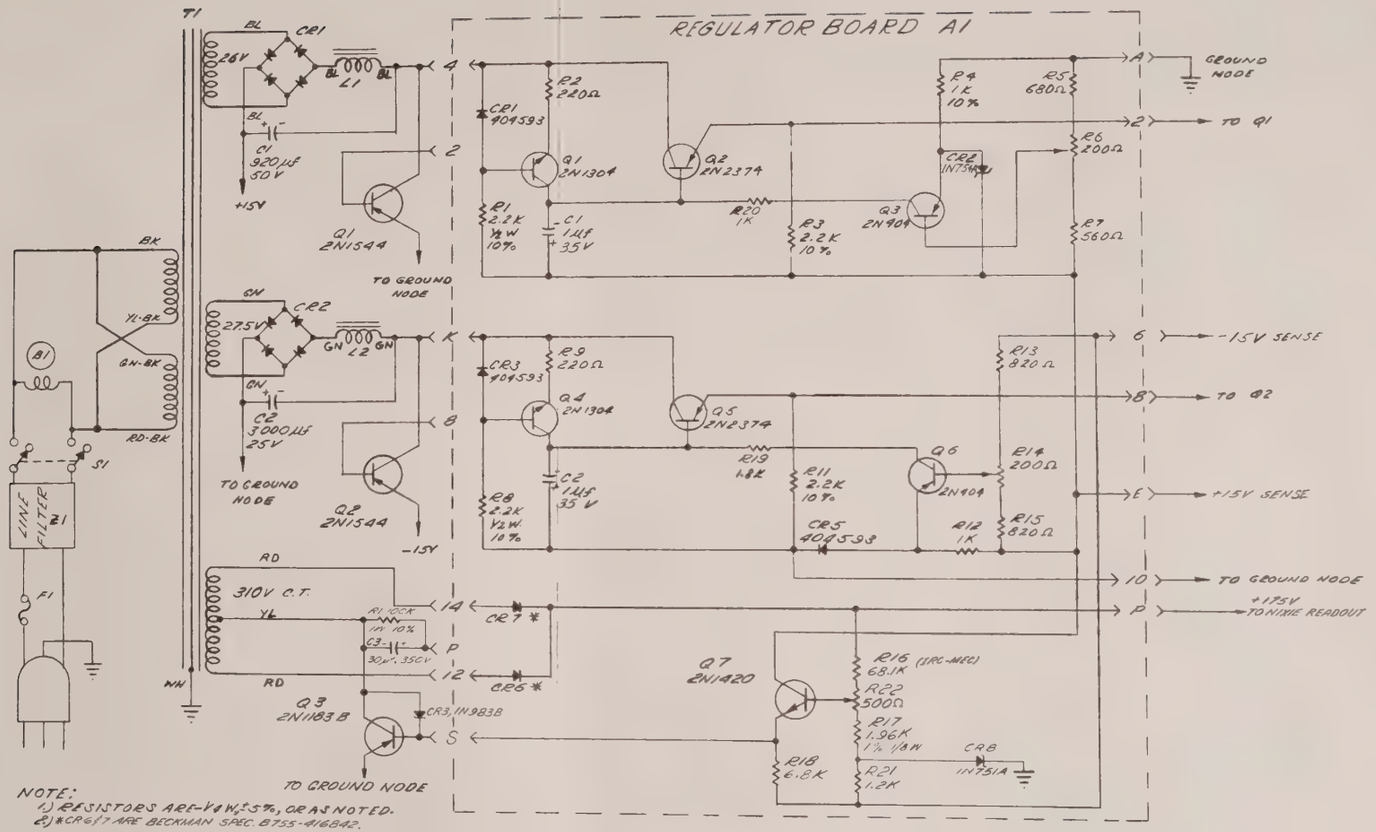




REGULATOR BOARD COMPONENT LAYOUT (A1)

REGULATOR BOARD (A1)
(Models 6003A, 6004A, 6005A)

Detail No.	Beckman Part No.	Description	Typical Manufacturer & No.	Qty./ Ass'y
A1	887-426753 E	Regulator Board	Beckman	1
C1, 2	631-844520	Capacitor, Elect., 1μf, 35V, ±20%	Kemet K1P35	2
CR1, 3, 5	755-404593	Diode, Special	Beckman	3
CR2	755-814019	Diode, Zener, 1N754A	Motorola	1
CR6, 7	755-416842	Diode, Special	Beckman	2
CR8	755-814045	Diode, 1N751A	Motorola	1
Q1, 4	755-817210	Transistor, Silicon, 2N1034	Texas Instruments	2
Q2, 5	755-836485	Transistor, Germanium, 2N2374	Texas Instruments	2
Q3, 6	755-800398	Transistor, Germanium, 2N404	Sylvania	2
Q7	755-817964	Transistor, Silicon, 2N1420	P.S.I.	1
R1, 8	601-008080	Resistor, F.Comp., 2.2K, 1/2W, 10%	Allen Bradley EB2221	2
R2, 9	601-822327	Resistor, F.Comp., 220Ω, 1/4W, 5%	Allen Bradley CB2215	2
R3, 11	601-812856	Resistor, F.Comp., 2.2K, 1/4W, 10%	Allen Bradley CB2221	2
R4	601-823111	Resistor, F.Comp., 1K, 1/4W, 10%	Allen Bradley CB1021	1
R5	601-822369	Resistor, F. Comp., 680Ω, 1/4W, 5%	Allen Bradley CB6815	1
R6, 14	611-812861	Resistor, Var., W.W., 200Ω	C.T.S. Series 111	2
R7	601-823396	Resistor, F.Comp., 560Ω, 1/4W, 5%	Allen Bradley CB5615	1
R12, 20	601-822308	Resistor, F.Comp., 1K, 1/4W, 5%	Allen Bradley CB1025	2
R13, 15	601-822306	Resistor, F.Comp., 820Ω, 1/4W, 5%	Allen Bradley CB8215	2
R16	607-844498	Resistor, F. Film, 68K, 1%	IRC MEC-TO	1
R17	607-821212	Resistor, F. Film, 1.96K, 1/8W, 1%	IRC CEA-TO	1
R18	601-822299	Resistor, F. Comp. 6.8K, 1/4W, 5%	Allen Bradley CB6825	1
R19	601-822544	Resistor, F. Comp. 1.8K, 1/4W, 5%	Allen Bradley CB1825	1
R21	601-822326	Resistor, F. Comp. 1.2K, 1/4W, 5%	Allen Bradley CB1225	1
R22	611-815619	Resistor, Var. W.W., 500Ω, 1.5W, 20%	CT.S. Series 111	1
	864-412958	Transistor Pad	Beckman	7



NOTE:
1.) RESISTORS ARE-1/4W, ±5%, OR AS NOTED.
2.) *CR6&7 ARE BECKMAN SPEC. B755-416842.

5.) TRANSISTORS 1, 2, & 3 ARE MOUNTED ON HEAT SINK

LOGIC SYMBOLS AND TYPICAL CIRCUITS

This section describes logic symbols as used in this manual. Typical circuit configurations are shown with each symbol. Actual circuits used in this instrument may be modifications of these typical circuits.

A. 1 AND GATE

The AND gate is a multiple-input circuit which requires that all inputs be present in order to produce an output.

A typical AND gate is shown in figure A-1.

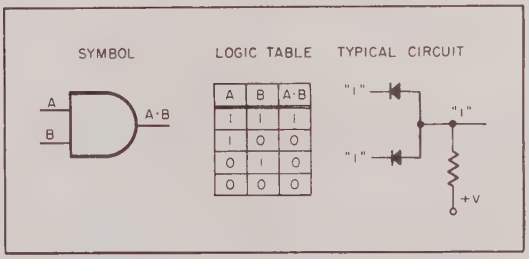


Fig. A-1. AND Gate

A. 2 OR GATE

The OR gate requires the presence of one or more inputs in order to produce an output.

A typical OR gate is shown in figure A-2.

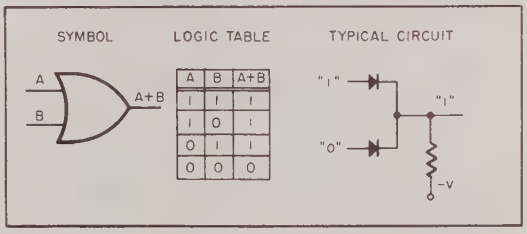


Fig. A-2. Typical OR Gate

A. 3 NAND GATE

The NAND gate is a multiple-input circuit which requires all inputs to be logic 1 in order to produce a logic 0 output.

A typical NAND gate is shown in figure A-3.

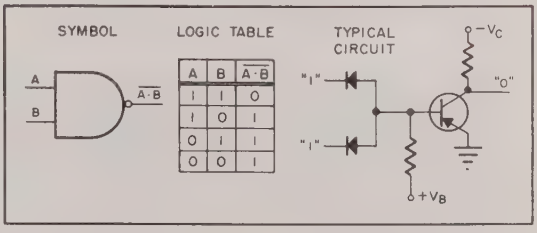


Fig. A-3. Typical NAND Gate

A. 4 NOR GATE

The NOR gate is a multiple-input circuit which requires all inputs to the gate to be logic 0 to produce a logic 1 output.

A typical NOR gate is shown in figure A-4.

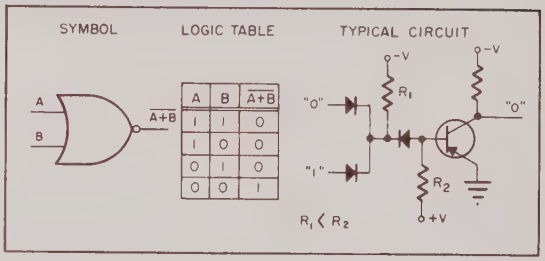


Fig. A-4. Typical NOR Gate

A. 5 POSITIVE AND NEGATIVE ZONE LOGIC

Unless stated otherwise, all logic symbols used in this publication refer to positive zone logic. Positive and negative zone logic are defined as follows.

1) Positive Zone Logic:

Positive zone logic exists when all pulses and/or levels occur on the positive side of the zero line.

When logic 1 is more positive than logic 0, it is called "positive zone, positive true". When logic 1 is less positive than logic 0, it is called "positive zone, negative true".

2) Negative Zone Logic:

Negative zone logic exists when all pulses and/or levels occur on the negative side of the zero line.

When logic 1 is less negative than logic 0, it is called "negative zone, positive true". When logic 1 is more negative than logic 0, it is called "negative zone, negative true".

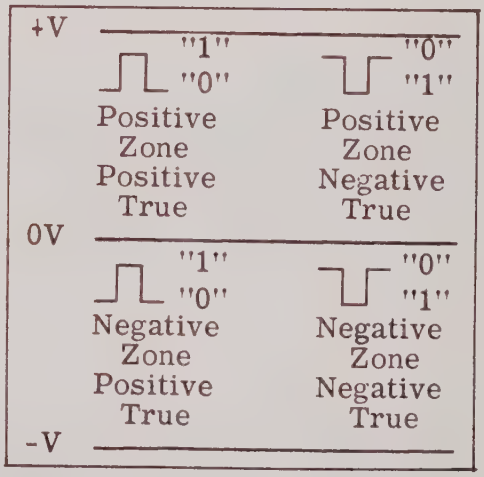


Fig. A-5. Positive and Negative Zone Logic

A.6 INVERTERS AND EMITTER FOLLOWERS

Logic inverting circuits provide a method of converting a logic 0 to a logic 1 or vice versa. Figure A-6 shows the inversion operation and a typical inverting circuit.

An emitter follower circuit is represented by the symbol (see figure A-6A). The circuit is so named because the output at the emitter follows the input in phase. This circuit may be used as a current amplifier or as a coupling or impedance matching element.

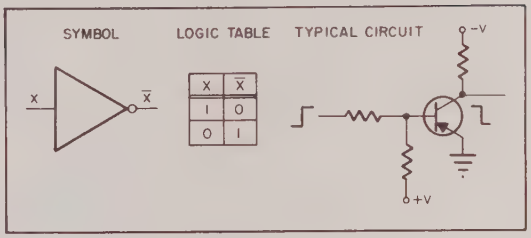


Fig. A-6. Typical Inverter

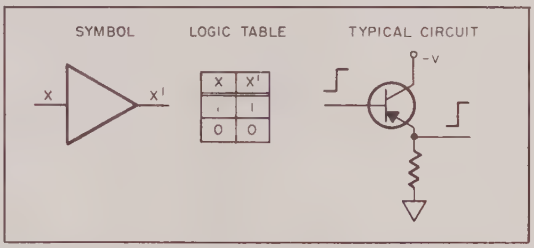


Fig. A-6A. Typical Emitter Follower

A.7 INVERTED TRUE INPUTS

When one input to a logic circuit requires a negative true signal where a positive true signal is usually required, a "not" (o) indication is shown at the particular input terminal of the logic symbol.

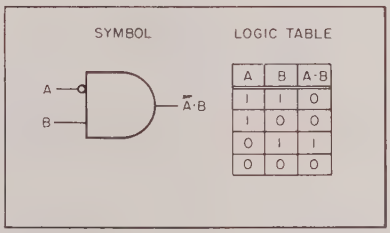


Fig. A-7. AND Gate Using Inverter Control Voltage Level

A.8 FLIP-FLOPS

The bistable multivibrator, or flip-flop, is characterized by having two states, logic 1 or logic 0. Since both states are stable, the binary is commonly used in memory circuits, counting circuits, and shift registers.

A typical flip-flop is shown in figure A-8. In the usual configuration, there are two input lines (logic 1 and logic 0) and two outputs (logic 1 and logic 0).

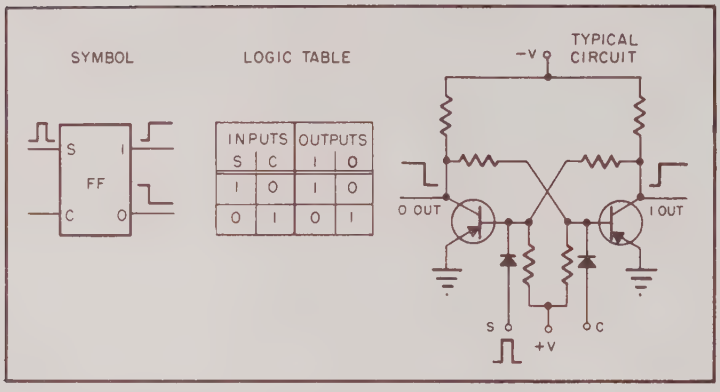


Fig. A-8. Typical Flip-Flop

A signal applied to the set input results in a logic 1 signal at the logic 1 output and a logic 0 signal at the logic 0 output. Conversely, a signal applied to the clear input results in a logic 0 at the logic 1 output and a logic 1 at the logic 0 output.

Positive Pulse Steering

Shown in figure A-8A is a flip-flop using PNP transistors and positive pulse steering. The circuit can exist in either of two stable states: Q1 on, Q2 off; or Q1 off, Q2 on.

Positive input pulses trigger the binary from one stable state to the other through one of the pulse-steering diodes (CR1 or CR2).

Circuit Description

With Q1 conducting and Q2 cut off, a positive input pulse passes through CR1 to the base of Q1. This turns Q1 off. As Q1 turns off, load current decreases and the collector potential approaches -15 volts. This negative transient is coupled through capacitor C1 to the base of Q2, turning Q2 on. Current through Q2 increases and its collector potential rises toward ground. Under these conditions, divider network R6-R4 maintains a positive potential at the base of Q1 to keep it cut off.

The flip-flop remains in this stable state (Q1 off, Q2 on) until the next positive input arrives. At this time, Q2 cuts off, Q1 conducts, and the binary resumes its original state.

NOTE

Logic 1 and logic 0 inputs may also be referred to as set and clear inputs.

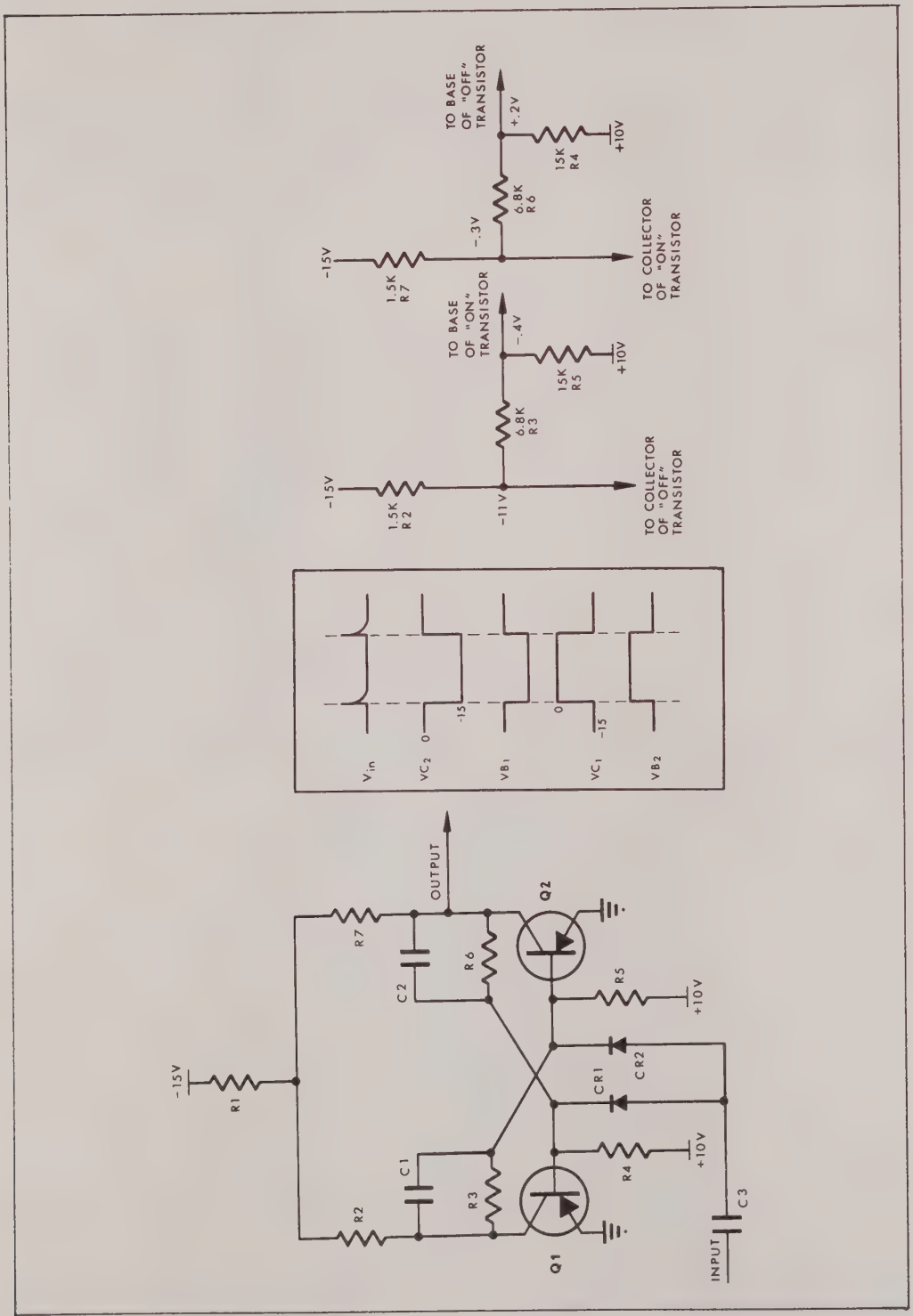


Fig. A-8A. Positive Pulse Steering

A.9 SINGLE-SHOT (MONOSTABLE) MULTIVIBRATOR

A typical single-shot (monostable) multivibrator is shown in figure A-9. Transistor Q1 is held at cutoff and transistor Q2 at saturation by bias arrangement and transistor regeneration. When a negative pulse is applied at the input, the circuit functions until a full cycle is complete. Circuit timing is determined by the values of capacitor C1 and resistor R2.

Single-Shot Circuit Description

A negative pulse is applied through coupling capacitor C2 to the base of transistor Q1, and it begins to conduct. The negative voltage at the collector of Q1 begins to fall. This positive transient is coupled to the base of transistor Q2, and forward bias on Q2 is decreased. Collector current of Q2 begins to decrease, and its collector voltage increases negatively. Part of this voltage is coupled through R4 to the base of Q1, increasing its negative potential. This regeneration results in a rapid change of both transistors; it drives Q1 into saturation and Q2 into cutoff. Since capacitor C1 was initially charged to -15 volts, the base of Q2 is at a positive potential of that magnitude (15 volts).

Capacitor C1 beings to discharge through R2 and the low resistance of Q1, and base potential of Q2 becomes less positive. When the base of Q2 becomes slightly negative, Q2 again conducts. Collector potential of Q2 increases positively and is coupled to the base of transistor Q1, driving it to cutoff. Transistor Q1 is again at cutoff and Q2 at saturation. This stable state is maintained until another negative pulse arrives to trigger the circuit.

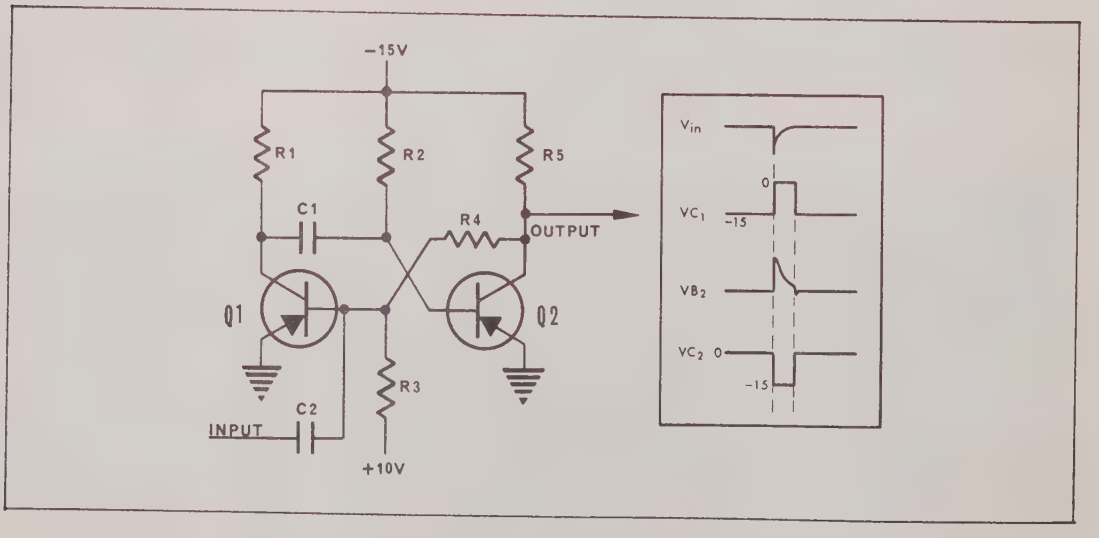


Fig. A-9. Typical Single-Shot Circuit

ECP	REV	ZONE	DESCRIPTION	POD No	DATE	BY	CHK'D	APP'D
	B		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	C		[illegible]	[illegible]	[illegible]	[illegible]		
	D		C23 WAS 500pf, 500V	11835	12-66	AJ		
	E		R34 WAS 5.6K	[illegible]	[illegible]	[illegible]	[illegible]	
	F		C22,23 WERE .005μF - C3 WAS 180pf - C9 WAS 75pf - DIODES A-931-24 WERE 420893 - Q11 - Q12,17 WERE 2N3605 A-420893 - R148 WAS 1.5K - ADD NOTE 3 THRU 9	11909	7-66	AJ		
	G		REV G PER TCO 11940	12019	6-29-67	DB		
	H		Q13 WAS 2N1420		6-29-67	DB		
	J		R77 WAS 1K, 1/4W; R17 WAS 5.6K, 1/4W, R7 WAS 4.7K, 1/4W; R8 WAS 47K, 1/4W, C2 WAS 130 PF, 500V.		6-29-67	DB		
	K		C11,C18 WERE .01μF, 50V DISC		6-29-67	DB		
	L		ADD CR24; NEW ARTWORK	12029	6-29-67	DB		

RESET TRIGGER

RESET GENERATOR #1

RESET GENERATOR #2

AUTO RESET DRIVER

CONTROL #1

DISPLAY TIME GENERATOR

ACCESSORY COMMAND DRIVER

DISPLAY TIME F/F

CONTROL INHIBIT DELAY

DATA SET SS

CONTROL #2

AUTO RESET

+15V

-15V

FRONT

REAR

NOTES:

1.) RESISTORS: ½ W, 5% UNLESS OTHERWISE NOTED
2.) CAPACITANCE IN pf " "
3.) DIODES: 420893 " "
*- DIODES: BIL A755-431324.
4.) TRANSISTORS: 425735 " "
5.) **DIODES: BIL A755-402107.
6.) ***-DIODE, BECKMAN, A755-404593.
7.) ◇-TRANSISTORS, BECKMAN, A755-419596.
8.) △-TRANSISTORS, BECKMAN, A755-422494.
9.) □-TRANSISTOR, BECKMAN, A755-424175.

R6 OMITTED

UNLESS OTHERWISE SPECIFIED	BY	DATE
TOLERANCES	DRAWN B. GRAFF	4-6-66
X ±.060 ANGULAR ±0° 30	CHK'D [illegible]	[illegible]
XX ±.030	ENG'R J. [illegible]	[illegible]
XXX ±.005 MACH. SURF ✓	APP'D	
THREADS CLASS 2A OR 2B	APP'D	
REMOVE BURRS & SHARP EDGES .020 MAX.		
MACH. FILLET RADIUS .020 R MAX.		
MACH. SURF. FLAT WITHIN .001 IN/IN		
OTHER SURF. FLAT WITHIN .003 IN/IN		
CONCENTRICITY MACH. SURF. TIR WITHIN ½ SUM OF DIA TOLS. .001 MIN.		
DO NOT SCALE DRAWING		

NEXT ASSY	USED ON
APPLICATION	

ITEM	PART NO.	DESCRIPTION	QTY.
TITLE	SCHEMATIC, TIMING CONTROL BD.		
MATERIAL			
FINISH			
SCALE		SIZE D	

Beckman
Berkeley Division, Richmond California

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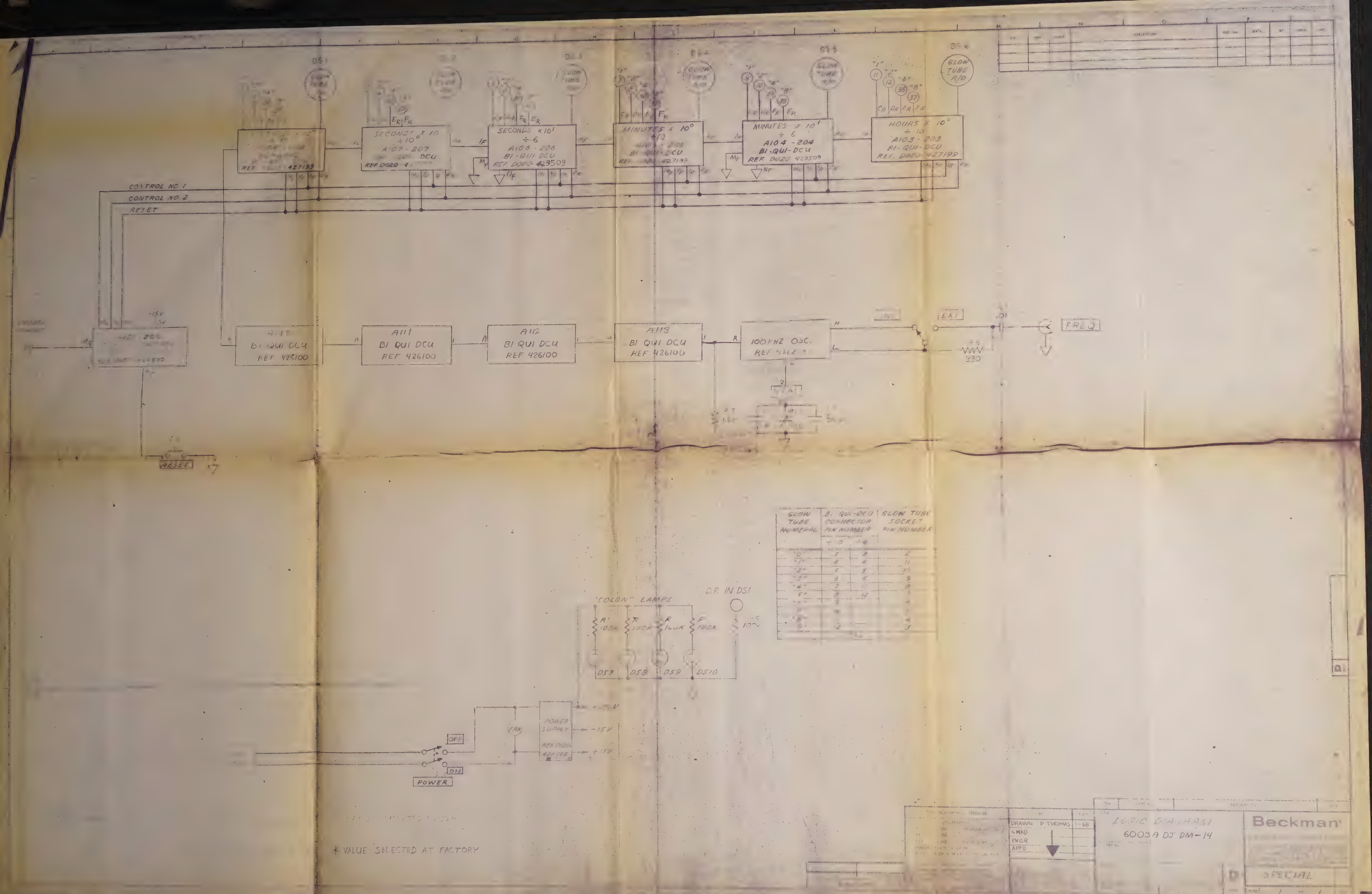
020-424590 L

SHEET 1 OF 1 REV.



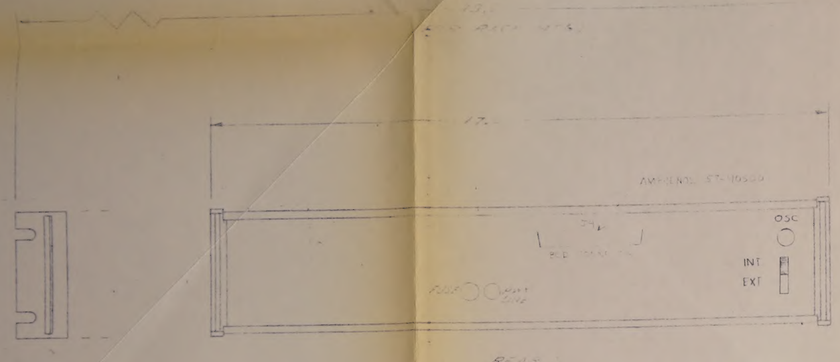
GLOW TUBE NUMERAL	BI QUI-DCU CONNECTOR PIN NUMBER ÷10	÷6	GLOW TUBE SOCKET PIN NUMBER
0	1	1	2
1	4	4	11
2	5	5	1
3	6	6	9
4	7	7	8
5	8	12	1
6	9		4
7	10		7
8	11		6
9	12		3

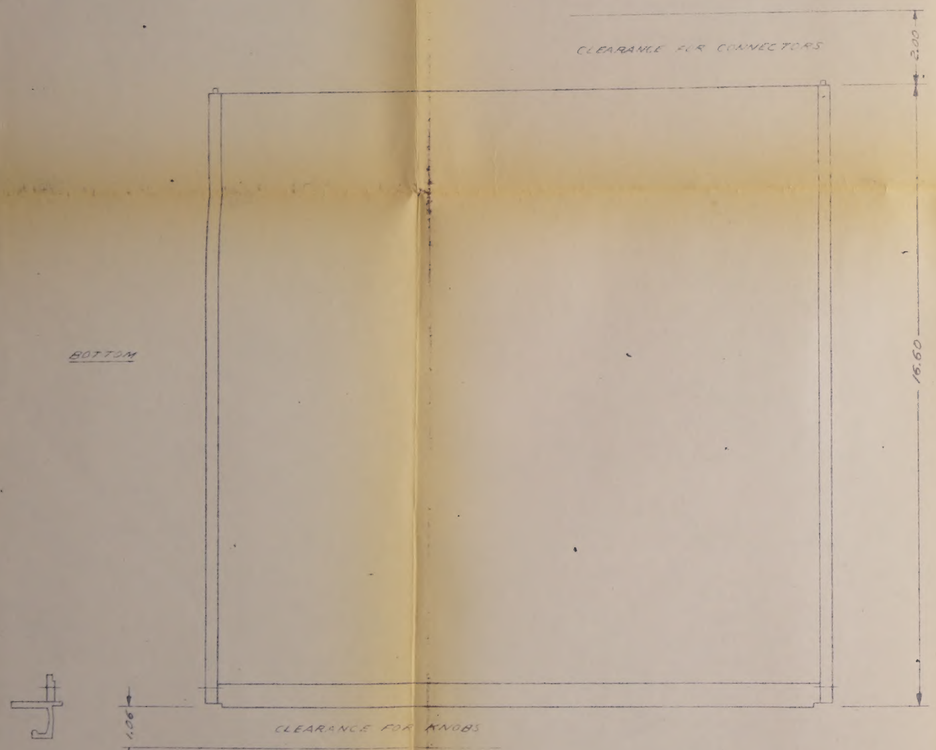
DRAWN	P THOMAS	1-68	LOGIC DIAGRAM 6003A DJ DM-14
CHKD			
ENGR			
APPD			

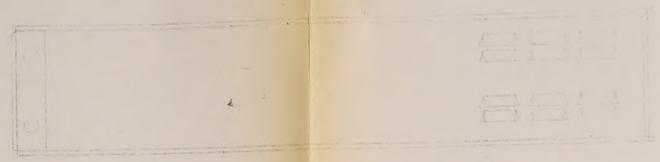
Beckman

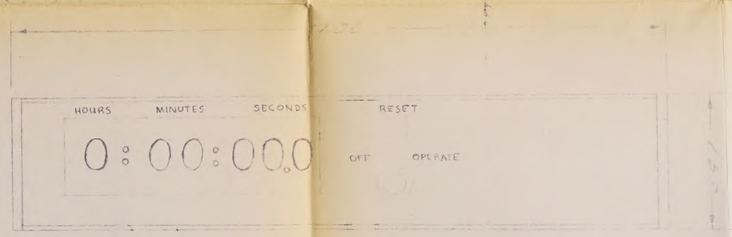
SPECIAL

SIZE D









60038-

TIMER, TEST

CODE IDENT NO	DWG NO
92208	120320

OUTLINE DRG. Beckman

SCALE HALF

D

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